

# Bothalia

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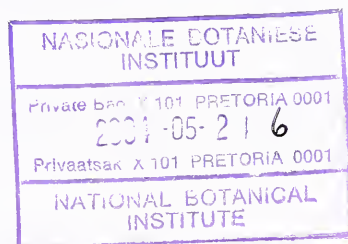
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# BOTHALIA

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# The genus *Cliffortia* (Rosaceae) in KwaZulu-Natal

C.M. WHITEHOUSE\*

**Keywords:** area of endemism, *Cliffortia* L., Drakensberg, KwaZulu-Natal, Rosaceae

## ABSTRACT

The only area of endemism for *Cliffortia* L. outside of the Cape Floristic Region (CFR) is centred in the northern KwaZulu-Natal Drakensberg. Eleven species of *Cliffortia* have been recorded from KwaZulu-Natal and distribution maps are provided for each. Clarification of the circumscription of *C. browniana* Burtt Davy is discussed and a new species, *C. dracomontana*, is described. *C. paucistaminea* Weim. is subdivided into two varieties: var. *australis* and var. *paucistaminea*. Comments on some of the other species that have frequently been misidentified are also provided along with a key to all the species in the area.

## INTRODUCTION

*Cliffortia* L. is the largest southern African genus within the Rosaceae. It was last comprehensively revised by Weimarck (1934, 1948) and subsequent published work has focused upon describing new species and clarifying taxonomy (Weimarck 1953, 1959; Oliver & Fellingham 1991, 1994; Fellingham 1993a, b, 1994, 1995, 2003). Recent work by Whitehouse (2003) using morphological and molecular techniques has indicated that some of the species boundaries need revising to reflect more accurately the diversity found within *Cliffortia*.

*Cliffortia* has its centre of diversity in the Fynbos Biome of the Cape Floristic Region (CFR) and over 80% of its species are endemic to that region (Goldblatt & Manning 2000; Whitehouse 2003). Linder (2001) stated several criteria to define areas of endemism: each area should contain at least two endemic species; the areas must be mutually exclusive; the areas must be narrower than the study area and several areas need to be defined for any discussion about their biogeography to be interesting; and finally, the ranges of the endemic species should be optimized to be maximally congruent. Using these criteria, only a single area of endemism exists outside of the CFR and is centred on the northern KwaZulu-Natal Drakensberg (Whitehouse 2003).

Eleven species of *Cliffortia* have been recorded within KwaZulu-Natal. *C. odorata* L.f. is recorded from a single old collection near Port Shepstone (Alexandra District, Hlokozi, 22 Feb. 1916, *Rudatis* 2242). The remaining species are either endemic to the Drakensberg or widespread, though scattered, through the province. *C. filicauloides* Weim. and *C. spathulata* Weim. are endemic to the northern KwaZulu-Natal Drakensberg, whereas the newly described species *C. dracomontana* C.M.Whitehouse is also endemic to the main Drakens-

berg escarpment but is found as far south as Ben Macdhui in Eastern Cape.

Despite the limited number of species present, the taxonomy and identification has often been confused. The flowers are small and remarkably uniform with few diagnostic characters. Therefore, species determination is primarily based upon vegetative characters, especially leaf form and achenes when present. However, whereas several species are easily determined from the leaves of their mature plants, their juvenile foliage (i.e. the first few true leaves of seedlings or of new shoots resprouting after a fire) is morphologically very different. Seedlings and resprouting plants of *Cliffortia* have frequently been incorrectly labelled as unrelated species and this has confounded the identification of otherwise easily discernible species. Mature plants also sometimes show ecotypic variation in the size and shape of their leaves, especially on the borders of forest or rivers compared with more exposed slopes. Furthermore, the possibility of hybridization and subsequent introgression as found in several Cape species (Weimarck 1934; Fellingham 1993a; Whitehouse 2003) cannot be dismissed, although no confirmed examples have yet been demonstrated within KwaZulu-Natal. A key is presented here that attempts to take account of these variations and to identify species, where possible, even when only juvenile foliage is present.

The conservation status of all the KwaZulu-Natal species of *Cliffortia* should be regarded as 'lower risk, least concern' for IUCN Red Data List assessments (Golding 2002). The widespread species are common and often weedy. In particular, *C. linearifolia* and *C. nitidula* subsp. *pilosa* are sometimes dominant and have then been used in defining certain vegetation types (e.g. Killick 1963; Edwards 1967). The endemic species are more localized but all grow within the protected area of the uKhahlamba-Drakensberg Park, generally on the higher slopes and in more inaccessible areas. As a result, although currently only recorded from a few scattered localities, they are probably present and common in the intervening parts of their ranges too.

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Key to KwaZulu-Natal species of *Cliffortia*

- 1a Leaves unifoliate, broadly ovate to subcircular, more than 10 mm wide ..... *odorata*
- 1b Leaves linear to obovate, less than 10 mm wide:
  - 2a Leaves unifoliate, narrowly oblong, usually more than 20 × 2 mm; growing in or beside water ..... *strobilifera*
  - 2b Leaves less than 20 mm long, if longer then belonging to a juvenile plant and trifoliate with needle-shaped leaflets:
    - 3a Leaves with petiole; leaflets broadly obovate and at least middle leaflet toothed:
      - 4a Plants decumbent or with arching stems; outer leaflets narrower than middle leaflet and only middle leaflet toothed; leaves sparsely hairy, sometimes only on midrib and margins; endemic to northern Drakensberg between Loteni River and Cathedral Peak ..... *filicauloides*
      - 4b Plants erect; middle leaflet similar to outer leaflets, all toothed; leaves hairy throughout ..... *nitidula* subsp. *pilosa* (juvenile foliage)
    - 3b Leaves without petiole, or if present then leaves oblong to linear and not toothed:
      - 5a Leaves unifoliate:
        - 6a Medium to tall shrub with virgate or tangled stems; young stems densely hairy; leaves with midrib and margins thickened so that they touch each other; sepals 4; stamens 4; stigma white to pinkish ..... *linearifolia*
        - 6b Low shrub with spreading stems that ascend towards apex; young stems glabrous or sparsely and very shortly hairy; leaves without noticeable thickening on midrib or margins; sepals 3; stamens 6; stigma red ..... *repens*
      - 5b Leaves trifoliate:
        - 7a Leaves sparsely hairy especially on young growth; margins usually inrolled beneath ..... *nitidula* subsp. *pilosa*
        - 7b Leaves always glabrous; margins not inrolled although sometimes thickened:
          - 8a Very short petiole, <1 mm long, often evident; leaves narrowly oblong, 2–8 × 0.5–1.0 mm, mucronate to rounded at apex; sepals 3 ..... *ramosissima*\*
          - 8b Petiole absent; sepals 4, very rarely 3 and then leaves needle-shaped with sharply pointed apex:
            - 9a Leaves linear to needle-shaped:
              - 10a Resprouting plants with leaflets more than 10 mm long, sterile:
                - 11a Stems densely, shortly hairy ..... *linearifolia* (juvenile foliage)
                - 11b Stems glabrous or almost so ..... *repens* (juvenile foliage)
              - 10b Mature foliage with leaflets less than 13 mm long:
                - 12a Midrib and margins of leaflets thickened so that they touch each other; apices obtuse to rounded ..... *linearifolia*
                - 12b Margins of leaflets not thickened; midrib slightly thickened to form a keel; apices acute to long acuminate:
                  - 13a Leaflets curved upwards and towards stem, giving a feathery appearance to branch; George to Port Elizabeth ..... *paucistaminea* var. *australis*
                  - 13b Leaflets straight or curved downwards and away from stem; brachyblasts sometimes appearing star-shaped; Port Elizabeth to KwaZulu-Natal ..... *paucistaminea* var. *paucistaminea*
      - 9b Leaves narrowly elliptic to broadly obovate:
        - 14a Leaves glaucous; margins always entire; bracteole margins smooth; achene 3–5 mm long; 2 400–3 100 m a.s.l. .... *dracomontana*
        - 14b Leaves glaucous or not; at least juvenile leaves toothed; if mature leaves entire then bracteole margins shortly ciliate and achene less than 3 mm long:
          - 15a Leaves broadly obovate, 1–4 mm wide; mature leaves toothed; achene 3–4 mm long; 1 800–2 800 m a.s.l. .... *spathulata*
          - 15b Leaves elliptic to narrowly obovate, 0.5–2 mm wide; mature leaves entire; achene less than 3 mm long:
            - 16a Leaflets narrowly elliptic; apices obtuse to acute; achene darkish brown, indistinctly ribbed; 1 000–2 500 m a.s.l. .... *browniana*
            - 16b Leaflet narrowly elliptic to obovate; apices rounded to obtuse; achene beige to pale brown, clearly ribbed; 0–1 600 m a.s.l. .... *serpyllifolia*

*Identity of C. browniana*

One species that has been particularly misunderstood in the past is *C. browniana* Burt Davy. Its type collection was from the Mpumalanga Drakensberg escarpment near Lydenburg, from where several similar collections have subsequently been made. Morphologically, *C. browniana* has no unique diagnostic character and is very difficult to separate from some small elliptic-leaved forms of *C. serpyllifolia* Cham. & Schltdl., with which it has often been confused. Within KwaZulu-Natal the two species need not be confused, as their distribution (see Figure 2) and altitude ranges do not overlap. However, the *C. serpyllifolia* grows on the Silotwane Hills of Swaziland, closer geographically to the type locality populations of

*C. browniana* than those in the KwaZulu-Natal Drakensberg. Consequently, the exact nature of the relationship between the Mpumalanga populations and the specimens also attributed to *C. browniana* in the KwaZulu-Natal Drakensberg needs to be clarified by molecular techniques.

The identity of *C. browniana* has been further confused by two distinct species being included under the same name within the KwaZulu-Natal Drakensberg. Originally Weimarck recognized the two entities as distinct, describing the specimen *Hutchinson 102* separately in the footnotes to *C. browniana*. However, when he later described *C. spathulata* he also included a picture of the latter entity (*Esterhuysen 10183*) under the name *C. browniana*. Consequently the two species have been included under the same name (e.g. Hilliard & Burt 1987). They are in fact easily distinguishable both in the herbarium and the field and the latter species is here described as *C. dracomontana*.

\* *C. ramosissima* has not been recorded from KwaZulu-Natal, but is included in the key because it is the only species that has also been recorded from the Free State, Mpumalanga, Limpopo and Lesotho. The key is therefore made more widely applicable by its inclusion.



Finally, the nature of the juvenile foliage of *C. browniana* has also caused confusion. Whereas the mature foliage has small, entire, narrowly elliptic leaves, the juvenile leaves are toothed. This caused Hilliard & Burtt (1987) to question whether it could be distinguished from *C. spathulata*. However, mature plants are easily distinguishable, especially if fertile, and the distribution of true *C. spathulata* does not actually include Hilliard & Burtt's study area of the southern Drakensberg. In contrast *C. dracomontana* has entire juvenile leaves, which provide another diagnostic character for that species. On the other hand, seedling leaves of *C. serpyllifolia* are also toothed and it is questionable whether juvenile plants of *C. browniana* could be distinguished from them on morphology if the locality was not known.

1. *C. browniana* Burtt Davy, A manual of the flowering plants and ferns of the Transvaal with Swaziland, South Africa 2: xxi, 316 (1932); Weim.: 56, fig. 13A–D (1934); Hilliard & B.L.Burtt: 162 (1987) pro parte. Type: Eastern Transvaal [Mpumalanga], 2530 (Lydenburg); Lydenberg, (–AB), Rogers 22985 (BOL, holo.!, K!).

*C. spathulata* auctt. non Weim.: Hilliard & B.L.Burtt: 163 (1987).

Erect, medium shrub, up to 0.5 m high; densely divaricately branched, forming brachyblasts; young stems 0.8–1.2 mm wide, reddish tinged, hairy; stem hairs upwardly adpressed, 0.2–0.7 mm long. Leaves trifoliate, chartaceous, 0.2–0.4 mm thick, midrib not prominent above lamina, ± held straight or slightly curved upwards and towards stem, green with two paler stripes on either side of midrib beneath, glabrous above and beneath;

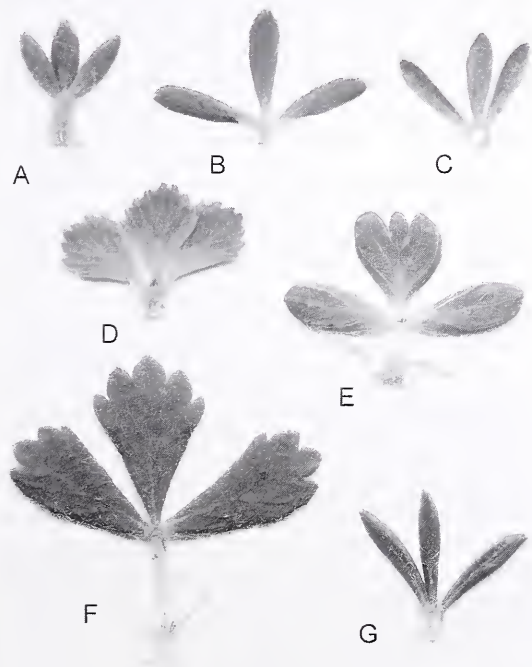


FIGURE 1.—Individual leaves of *Cliffortia* species. × 3. A, *C. browniana*; B, *C. dracomontana*; C, *C. serpyllifolia*; D, *C. spathulata*; E, *C. filicauloides*; F, juvenile leaf of *C. nitidula* subsp. *pilosa*; G, mature leaf of *C. nitidula* subsp. *pilosa*.

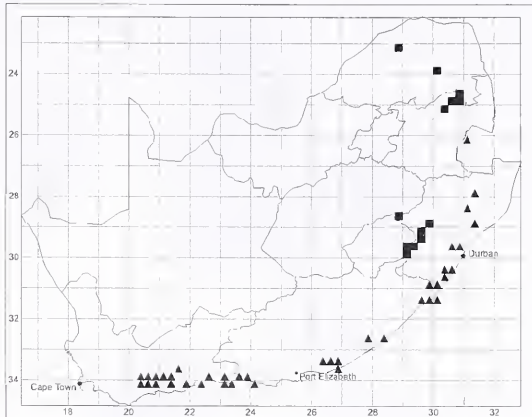


FIGURE 2.—Known distribution of *Cliffortia browniana*, ■, and *Cliffortia serpyllifolia*, ▲, in southern Africa.

sheath 0.9–1.4 mm long, abaxially glabrous, adaxially hairy; stipules 0.4–1.2 mm long, free, margin ciliate; petiole absent; leaflets elliptic, 1.9–4.3 × 0.6–1.3 mm, apex acute, margins flat, entire. Flowers solitary in axil of undifferentiated leaves; bracteoles glabrous except for ciliate margins; sepals 4, glabrous. Male flowers unknown. Female flowers: bracteoles 1.3–2.1 mm long, longer than immature receptacle; sepals ovate, 0.9–1.4 × 0.4–0.7 mm, recurved; carpels 1 or 2; stigma 0.9–1.3 mm long, red, feathery, ± hidden by leaves; immature receptacle 1.0–1.3 × 0.6–0.8 mm, glabrous, smooth. Achene 2.1–2.4 × 1.0–1.3 mm, medium brown, glabrous, faintly or indistinctly ribbed. Flowering time: November to May. Figure 1A.

Habitat: quartzitic sandstone derived soils in full sun, often in damp areas or amongst rocks; altitude 1 050–2 500 m.

Distribution: KwaZulu-Natal Drakensberg escarpment from Sehlabathebe in Lesotho to Witsieshoek, with a disjunction to the Mpumalanga Drakensberg escarpment between Graskop and Wolkberg, and an outlying population on Blouberg. Figure 2.

Etymology: not explicitly stated but presumably named after N.E. Brown.

2. *C. dracomontana* C.M.Whitehouse, sp. nov., *C. browniana* Burtt Davy affinis, sed foliis obovatis glaucis longioribus, juvenibus foliis integris, bracteolis glabris, fructibus majoribus differt.

TYPE.—KwaZulu-Natal, 2929 (Underberg): 8–11 km NNW of Castle View Farm, headwaters of Mlahlangubo River, (–CB), Hilliard & Burtt 13561 (NU, holo.!, K!, PRE).

*C. browniana* auctt. non Burtt Davy: Weim.: 56 (1934) pro parte; Weim.: t. 5 (1948); Killick: 127 (1963); D.Edwards: 264 (1967) pro parte; J.H.Ross: 183 (1972); Hilliard & B.L.Burtt: 162 (1987) pro parte.

Erect, low to medium shrub, up to 0.5 m high; densely divaricately branched, forming brachyblasts; young



FIGURE 3.—*Cliffortia dracomontana*. A, fruiting branch,  $\times 2.5$ ; B, achene  $\times 5$ .

stems 0.7–1.0 mm wide, often reddish tinged, hairy; stem hairs upwardly adpressed, 0.2–0.5 mm long. *Leaves* trifoliate, chartaceous, 0.1–0.3 mm thick, midrib not prominent above lamina, held  $\pm$  straight, glaucous, glabrous above and beneath; sheath 0.9–1.5 mm long, abaxially glabrous, adaxially markedly hairy; stipules 0.8–1.5 mm long, free, margin smooth; petiole absent; leaflets elliptic to obovate, 2.8–6.0  $\times$  0.7–2.1 mm, apex obtuse to rounded, margins flat, entire. *Flowers* solitary in axil of undifferentiated leaves; bracteoles glabrous, margins smooth; sepals 4, glabrous. *Male flowers*: pedicel 0.5–0.7 mm long; sepals broadly ovate, 2.5–3.1  $\times$  0.9–1.2 mm, acute to acuminate at apex; stamens 4–6; filaments 1.8–2.3 mm long. *Female flowers*: bracteoles 1.7–2.5 mm long, longer than immature receptacle; sepals ovate, 1.2–1.5  $\times$  0.5–0.6 mm, recurved; carpel 1; immature receptacle glabrous, smooth. *Achene* 2.9–4.5  $\times$  1.3–1.8 mm, brown, glabrous, faintly ribbed and slightly tuberculate to rugose. *Flowering time*: October to November. Figures 1B; 3.

*Habitat*: basalt-derived, well-drained soils and scree in full sun; altitude 2 150–3 100 m.

*Distribution*: Drakensberg escarpment, from Mont-aux-Sources to Ben Macdhui. Figure 4.

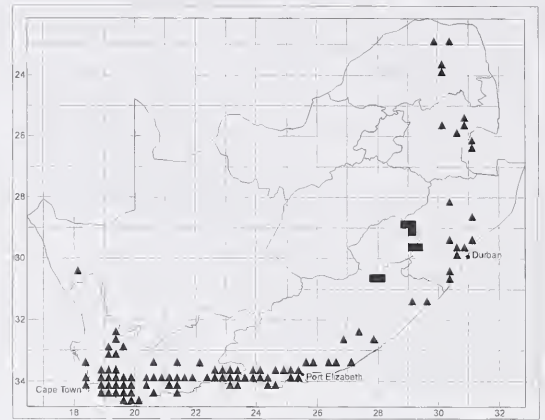


FIGURE 4.—Known distribution of *Cliffortia dracomontana*, ■; and *Cliffortia strobilifera*, ▲, in southern Africa.

*Etymology*: named after the Drakensberg Mountain Range in which it is endemic.

Hilliard & Burtt (1987) cite two specimens for *C. browniana*, their number 13561 (incorrectly cited as 13651) is *C. dracomontana*, whereas Guillardmod *et al.* 218 is a true *C. browniana*. The two species are easily distinguished—*C. dracomontana* has glaucous leaves,  $\pm$  3–6 mm long, often obovate with rounded apices and smooth stipules, whereas *C. browniana* has green leaves, often with two pale stripes on either side of the midrib beneath, usually less than 4 mm long, always elliptic, with an acute apex and ciliate stipules. Furthermore, the achenes of *C. dracomontana* are large, 3.0–4.5 mm long, and have glabrous bracteoles, as opposed to *C. browniana*, which has achenes 2.0–2.5 mm long and bracteoles with ciliate margins. The juvenile leaves of *C. dracomontana* show no evidence of any toothing in contrast to *C. browniana*, which are toothed although still narrowly elliptic.

Preliminary molecular evidence suggests that *C. dracomontana* is more closely related to *C. spathulata* than *C. browniana*. *C. spathulata* shares with *C. dracomontana* the glaucous leaves, smooth stipules and larger achenes.

3. *C. spathulata* Weim. in Botaniska Notiser 90: 180, t. 5 (1948); J.H.Ross: 183 (1972). Type: Natal [Kwa-Zulu-Natal] 2929 (Underberg); Amawahqua [Mahwaqa] Mtn, (–DC), Medley Wood 4578 (K, holo.).

*C. browniana* auct. non Burtt Davy: Weim.: 56, fig. 13E–H (1934) pro parte.

Erect, medium shrub, up to 1 m high, resprouting after fire from a single crown; densely divaricately branched, forming brachyblasts; young stems 0.7–1.2 mm wide, reddish tinged, hairy; stem hairs upwardly adpressed, 0.1–0.6 mm long. *Leaves* trifoliate, chartaceous, 0.2–0.3 mm thick, midrib not prominent above lamina, curved upwards and towards stem, glaucous, glabrous above and beneath; sheath 0.9–1.5 mm long, abaxially glabrous, adaxially markedly hairy; stipule 0.6–1.1 mm

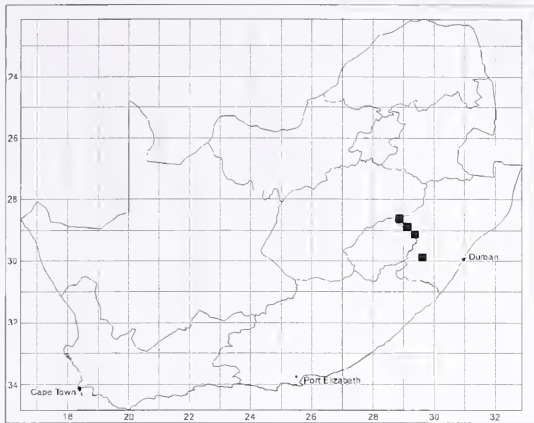


FIGURE 5.—Known distribution of *Cliffortia spathulata* in southern Africa.

long, free, margin smooth; petiole absent; leaflets broadly obovate,  $2.4\text{--}6.1 \times 1.2\text{--}3.4$  mm, base contracted abruptly to form a pseudopetiolule, apex acute to rounded, margins flat, markedly toothed or lobed with 3–7 straight teeth,  $0.05\text{--}0.25$  mm long. *Flowers* solitary in axil of undifferentiated leaves; bracteoles glabrous, margins serrate to shortly ciliate; sepals 4, glabrous. *Male flowers*: bracteoles  $1.6\text{--}2.6$  mm long; pedicel  $0.6\text{--}0.9$  mm long; sepals broadly ovate,  $2.6\text{--}4.2 \times 1.3\text{--}2.3$  mm, acute to acuminate at apex; stamens 5 or 6; filaments  $2.8\text{--}4.1$  mm long, red; anthers brownish red. *Female flowers*: bracteoles  $2.2\text{--}2.8$  mm long, longer than immature receptacle; sepals ovate,  $1.9\text{--}2.4 \times 0.7\text{--}1.0$  mm, recurved; carpel 1; stigma  $2.4\text{--}3.5$  mm long, white to red, feathery; immature receptacle  $1.7\text{--}2.2 \times 0.6\text{--}0.9$  mm, glabrous, smooth. *Achene*  $3.2\text{--}3.5 \times 1.0\text{--}1.1$  mm, medium brown, glabrous, faintly ribbed and slightly tuberculate to rugose. *Flowering time*: November to December.

*Habitat*: Clarens Formation sandstone or basalt-derived soils in full sun on well-drained soils; altitude 1 800–2 750 m.

*Distribution*: northern Drakensberg between Witsieshoek and Monk's Cowl (but see note below). Figure 5.

*Etymology*: *spathulata* means spoon- or spatula-shaped, referring to the leaflets that have a broad apex, then taper down into a narrow stalk.

The type locality of *C. spathulata* is recorded as Mahwaqa Mtn above Bulwer by Medley Wood. However, this mountain is relatively far from the currently known distribution of the species on the Drakensberg escarpment to the north. Furthermore, *C. spathulata* has not been recollected from that mountain and was not reported in a recent survey (Meter *et al.* 2002). It is therefore probable that the type locality has been erroneously recorded.

4. *C. linearifolia* Eckl. & Zeyh.

Hilliard & Burt (1987) note that this species has two forms in the southern Drakensberg, one forming tall vir-



FIGURE 6.—Known distribution of *Cliffortia linearifolia* in southern Africa.

gate shrubs with unifoliate foliage and the other shorter and densely branched with trifoliate leaves. The unifoliate form is found in wetter areas, such as along watercourses, whereas the trifoliate form is found on rocky outcrops and drier slopes. However, both forms have similar distribution patterns (Figure 6) and it is not possible to determine from morphology alone whether they constitute distinct varieties or just ecotypes. Molecular work and/or transplantation experiments are needed to examine these two entities to establish the degree of phenotypic plasticity within the species.

5. *C. nitidula* (Engl.) R.E.Fr. & T.C.E.Fr. subsp. pilosa Weim. and *C. filicauloides* Weim.

One of the most marked occurrences of dimorphism between juvenile and mature leaves is found in *C. nitidula* (Engl.) R.E.Fr. & T.C.E.Fr. subsp. *pilosa* Weim. (Figure 7). Whereas the mature foliage has needle-shaped leaflets typical of many species of *Cliffortia*, the leaves of seedlings and resprouting growth after fire are trifoliate with a petiole and broadly toothed leaflets. It has therefore been frequently confused with the northern

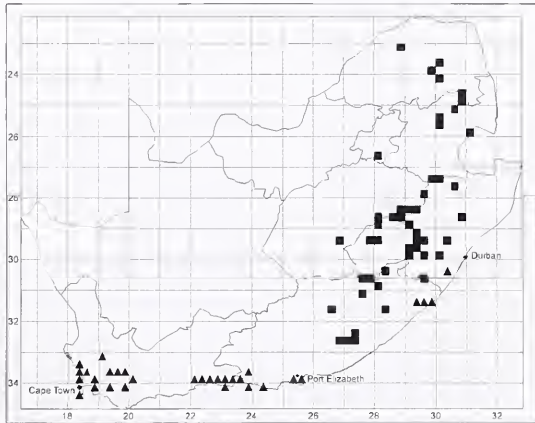


FIGURE 7.—Known distribution of *Cliffortia nitidula* subsp. *pilosa*, ■; and *Cliffortia odorata*, ▲, in southern Africa.



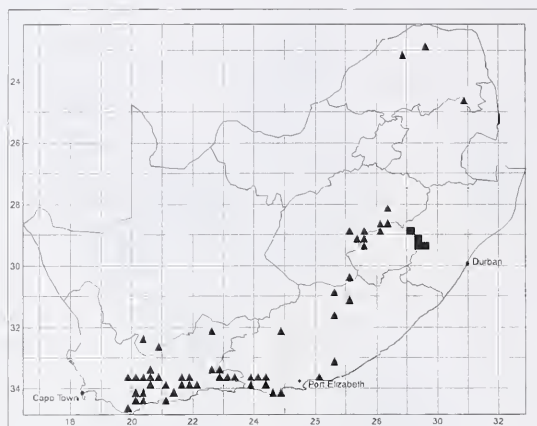


FIGURE 8.—Known distribution of *Cliffortia filicauloides*, ■, and *Cliffortia ramosissima*, ▲, in southern Africa.

Drakensberg endemic *C. filicauloides* (Figure 8), a species whose closest relatives are in fact found in the CFR (Whitehouse 2003). In the field, confusion is unlikely as the habit of *C. nitidula* subsp. *pilosa* is always erect, whereas *C. filicauloides* forms arching stems that sprawl across boulders and down slopes, and the juvenile nature of the shoots is usually evident. Furthermore, shoots with juvenile leaves appear to be always sterile, thus flowering material will belong to *C. filicauloides*. Sterile herbarium material can best be distinguished by examining the lateral leaflets, which are toothed and similar in size and shape to the middle leaflet in *C. nitidula* subsp. *pilosa*, but generally untoothed and narrower than the middle leaflet in *C. filicauloides*.

*Subdivision of C. paucistaminea* Weim. and typification of *C. galpinii* N.E.Br.

*C. paucistaminea* Weim. is a widespread species from the Outeniqua Mountains to the KwaZulu-Natal Drakensberg. It is easily recognizable over most of its range by its four-sepalled flowers and needle-shaped leaves that occur on closely overlapping brachyblasts. However, two distinct forms can be recognized. Between George and Port Elizabeth, the leaves are strongly curved upwards and towards the stem, accentuating the overlapping nature of the brachyblasts. In addition, the leaflets are quite fine, 0.3–0.5 mm wide, and the young stems as a whole have a feathery appearance, resembling the Western Cape species *C. exilifolia* Weim. (which has only three sepals). To the north and east of Port Elizabeth the leaves are straighter or sometimes recurved away from the stem, when the brachyblasts then appear starlike, and the leaflets are generally broader.

Unlike *C. linearifolia* Eckl. & Zeyh. above, the two forms also have a geographical separation and therefore attributing them a taxonomic rank is appropriate. However, the variation could be the result of clinal differentiation associated with climatic factors: the southern populations are subject to year-round rainfall, whereas those further north have an increasingly dominant summer rainfall pattern. Morphometric studies along with population-level molecular work are needed across the

range of the species to determine if there is continuous gene flow between the two varieties or if they would be better regarded as distinct species. In this case, particular attention needs to be focused on the border between the two varieties in the mountains around Port Elizabeth.

Weimarck identified that the type collection of the name *C. galpinii* N.E.Br. included two different elements: *C. paucistaminea* and *C. ramosissima* Schltr. He therefore regarded the name as a *nomen confusum*. However, this is an unsatisfactory solution as the name has precedence over *C. paucistaminea* but not over *C. ramosissima*. To prevent the name *C. galpinii* being accidentally resurrected, it is important to typify the name with the *C. ramosissima* element and thereby relegate it to synonymy. The Kew collections of *Galpin 1607* are ambiguous with regard to their locality, stating 'Hangklip and Andriesberg Mountains' for both specimens. However, the Bolus and Grahamstown specimens state only Andriesberg for the *C. ramosissima* element, whereas the BOL and PRE specimens both state Hangklip Mtn for the *C. paucistaminea* element. It would therefore seem logical to deduce that Andriesberg should now be attributed as the type locality.

6. *C. paucistaminea* Weim. in Botaniska Notiser 1933: 151, fig. 4c, d (1933); Weim.: 64, fig. 16A–E (1934); J.H.Ross: 183 (1972); Hilliard & B.L.Burt: 162, t. 6C (1987); Pooley: 150 (1998); Fellingham: 615 (2000). Type: Basutoland [Lesotho], *Cooper 690* (K, holo.!; B, BOL!, W, Z).

*C. galpinii* auct. non N.E.Br. sensu stricto: N.E.Br.: 122 (1901) pro parte.

*C. juniperina* auct. non L.f.: Jacot-Guillarmod: 186 (1971).

Erect, medium to tall shrub, up to 2 m high, resprouting after fire and sometimes spreading clonally; densely divaricately branched, forming brachyblasts, which are closely overlapping; young stems 0.8–1.7 mm wide, hairy; stem hairs upwardly adpressed, 0.2–0.6 mm long. Leaves trifoliate, chartaceous, 0.1–0.4 mm thick, midrib keeled and prominent, green with two paler stripes on either side of midrib beneath, glabrous above and beneath; sheath 0.6–1.5 mm long, abaxially glabrous, adaxially glabrous to markedly hairy; stipules 1.5–2.3 mm long, free, margin smooth; petiole absent; leaflets linear to needle-shaped, 5.1–10.2 × 0.3–0.8 mm, apex sharply acuminate, 0.4–0.8 mm long, margins flat, minutely serrulate to scabrid. Flowers solitary in axil of undifferentiated leaves; bracteoles hairy, margins serrate to shortly ciliate; sepals 4, or very rarely 3, glabrous. Male flowers: bracteoles 0.9–1.8 mm long; pedicel 0.3–0.8 mm long; sepals broadly ovate, 2.2–3.6 × 0.9–1.5 mm, acute to acuminate at apex; stamens 4(–6); filaments 1.4–3.7 mm long, reddish; anthers yellow to brownish red. Female flowers: bracteoles 1.6–2.6 mm long, longer than immature receptacle; sepals narrowly ovate, 1.1–1.7 × 0.3–0.5 mm, erect to recurved; carpel 1; stigma 2.5–3.7 mm long, greenish white, feathery, hidden at base of leaves; immature receptacle 1.0–1.8 × 0.6–0.9 mm, glabrous, clearly ribbed. Achene 2.1–3.3 × 0.9–1.2 mm, pale yellowish brown, glabrous; ribs 8–16, rounded to acute, 0.1–0.2 mm wide.



FIGURE 9.—Example specimen of *Cliffortia paucistaminea* var. *paucistaminea*, Transkei, Engcobo District, hills near Engcobo, Esterhuysen 29149 (BOL).

*Etymology:* *paucistaminea* means few stamens, referring to the male flowers that only have 4 stamens, although a number of other species also have that few.

6a. var. **paucistaminea**

*Leaflets* 0.4–0.8 mm wide, held straight or curved downwards and away from the stem. *Flowering time:* predominantly September to February. Figure 9.

*Habitat:* found in humus-rich soil over sandstone rocks in full sun; altitude 0–2 350 m.

*Distribution:* widespread from the Suurberg Mountains along the Drakensberg escarpment as far as Giant's Castle, with outlying populations along the Wild Coast and KwaZulu-Natal lowlands as far north as Nkandla. Figure 10.

6b. var. **australis** C.M.Whitehouse, var. nov., a var. *paucistaminea* ramulis plumosis differt.

**TYPE.**—Eastern Cape, 3424 (Humansdorp): Witte Els Bosch [Witelsbos], flats, (–AA), *Fourcade 2114* (BOL, holo.!; K!, LD, NBG!, PRE).

*Leaflets* 0.3–0.5 mm wide, curved upwards and towards stem, giving the branches a feathery appearance.

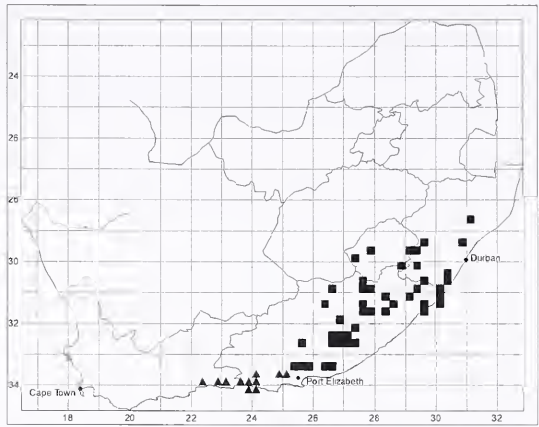


FIGURE 10.—Known distribution of *Cliffortia paucistaminea* var. *paucistaminea*, ■; and *Cliffortia paucistaminea* var. *australis*, ▲, in southern Africa.

*Flowering time:* predominantly November to April. Figure 11.

*Habitat:* humus-rich Table Mountain Sandstone derived soils, in full sun and on well-drained soils, but areas



FIGURE 11.—Holotype of *Cliffortia paucistaminea* var. *australis*, Witte Els Bosch, flats, *Fourcade 2114* (BOL).



where it grows are subject to frequent rain and cloud; altitude 50–1 550 m.

**Distribution:** southern Cape mountains and lowlands between George and Uitenhage. Figure 10.

**Etymology:** *australis* means southern, referring to the distribution of the variety in the southern Cape.

7. *C. ramosissima* Schltr. in Botanische Jahrbücher 24: 444 (1897); Weim.: 73, fig. 18L–R (1934); Weim.: 419 (1946). Type: Western Cape, 3419 (Caledon): Elim, (–DB), *Schlechter* 7633 (B, holo.; BOL!, COI, G-DEL, GRA, K!, HBG, L, NH, P, PRE, SAM, W, WAG, Z).

*C. galpinii* N.E.Br.: 122 (1901) pro parte. Lectotype, here designated: Eastern Cape, Queenstown District, Andriesberg, *Galpin* 1607: *C. ramosissima* element (K, lecto!; BOL!, GRA!).

8. *C. repens* Schltr. and *C. erectisepala* Weim.

Weimarck described *C. erectisepala* from a single collection from Paarl Mountain. He subsequently commented on collections from Franschhoek (Weimarck 1940) and Swellendam (Weimarck 1946). *C. repens* Schltr. he applied to unifoliate, needle-leaved collections from Uitenhage to Pietersburg. However, morphologically the collections from Uitenhage to Grahamstown are closer to *C. erectisepala*, having shorter, narrower leaves, upright erect habit, and non-spreading sepals. More recent collections have extended the range of *C. erectisepala* from Gifberg in the north to Rooiberg in the Little Karoo. The species in general is very inconspicuous and the current study has revealed that it is in fact much more common and widespread with many new localities being recorded. Consequently, the disjunction between Western Cape populations and the narrow-leaved Eastern Cape populations of *C. repens* is not as marked as originally thought. Therefore, these populations are now included in *C. erectisepala*, whereas the range of true *C. repens* is reduced and extends only as far south as Baziya Mtn near Umtata. This change is significant biogeographically, as *C. repens* is no longer part of the Cape Flora and is better regarded

as a broad Drakensberg endemic, whereas *C. erectisepala* can be counted as a Cape Ubiquist (sensu Weimarck 1941) (see Figure 12).

A single collection is incongruous with this re-organization. The sheets are labelled as collected by Thorncroft (in *Herb. Rogers* 19187) from Barberton and are typical of *C. erectisepala*, although only male flowers are present. However, no other collections have been made in this well-collected area that resemble *C. erectisepala* and it is therefore presumed that the locality is erroneous.

#### SPECIMENS EXAMINED

Abbott 177 (6a) PRE. Acocks 10217 (1) PRE; 11462 (1) NBG, PRE; 12037 (6a) PRE; 13838, 18690, 20159, 21884 (6a) K, PRE. Acocks & Hafstrom 571 (4) PRE.

Balkwill, Manning & Meyer 790 (5) K, NU; 792 (5) NU; 793 (3) NU. Balkwill, Manning et al. 1030 (6a) NU. Baur 494 (8) K. Bayer 815 (8) NU. Bayliss 493, 1347 (6a) PRE. Bean, Viviers & Cloete 2274 (6a) BOL. Bews 1413 (8) NU. Bolus 250 (6a) BOL. Bond 1210 (6b) BOL, PRE. Britten 4663 (6a) GRA, PRE; 6408 (6a) GRA. Bruce 495 (8) K, PRE. Buitendag 827 (8) K, NBG, PRE. H. & J. Burrows 4720 (8) GRA. Burr Davy 1560 (8) BOL, PRE.

Comins 581 (4) NU. Compton 7313 (8) NBG; 10458 (6b) NBG; 19176 (6a) NBG; 19746, 19789, 22377 (8) NBG; 23500 (6b) NBG; 24742 (8) NBG; 26285, 27606 (8) K, NBG, PRE; 28510, 30531 (8) NBG, PRE. Cooper 690 (6a) BOL, K. Crewe 24 (5) NU. Curator Pretoria Bot. Garden 21565 (8) PRE.

Davidson & Mogg 33405 (8) K, PRE. Deall 2303 (8) PRE. Devenish 1976 (5) NU. Dickinson 4 (6b) BOL. Dieterlen 1103, 1203 (6a) NBG, PRE. Dolne Research Institute 4 (6a) GRA. Dold 815 (6a) GRA. Downing 104 (4) NU. Drège 5381 (4) K. Dyer & Collett 4700 (8) PRE.

Edwards 244 (4) NU; 596 (2) NU, PRE; 928 (4) NU; 976 (4) NU, PRE; 2013 (3) NU; 2233 (8) K, NU, PRE; 2235, 2248 (5) NU; 2456 (1) K, NU, PRE; 4054 (8) K. PRE. Esterhuysen 4569 (6b) BOL; 6810 (6b) BOL, PRE; 7930 (8) BOL; 8843 (3) BOL; 8846 (4) BOL; 10180 (3) BOL, K; 10181 (5) BOL, K; 10183 (2) BOL; 10184 (8) BOL, K, NBG, NU; 10816 (6b) BOL; 10854 (6b) BOL, K; 12867 (8) BOL, PRE; 12871 (3) BOL; 12886 (2) BOL; 13222, 13259 (6a) BOL; 13578 (6b) BOL; 14527 (8) BOL, NBG, PRE; 14528 (8) BOL; 15482 (2) BOL, NBG, PRE; 15484 juvenile (5) BOL; 15485 (3) BOL; 15489 (8) BOL, NBG; 15635 (3) BOL; 16272 (6b) BOL; 16770 (6b) BOL, NBG, PRE; 17342 juvenile (5) BOL, PRE; 18661 (2) BOL, NBG; 18662 (3) BOL, PRE; 18684 (5) BOL; 21447 (1) BOL, K, PRE; 21687 (2) BOL; 27113 (6b) BOL, PRE; 27374 (6b) BOL; 27541 (6b) BOL, PRE; 27846 (8) BOL; 29149 (6a) BOL, K. Evans 663 (8) K, PRE.

Fellingham 1631 (6a) NBG, PRE; 1632, 1671, 1672 (6a) NBG. Feltham 155 (5) NU. Forrester & Gooyer 204 (1) PRE. Fourcade 2114 (6b) BOL, K, NBG, PRE. Galpin s.n. (8) BOL; 1607 (6a) BOL, K, PRE; 2255, 8307 (6a) PRE; 9439 (4) K, PRE; 13072 (8) K, PRE. Germishuizen 5778 (8) PRE. Gerrard 1568 (8) K. Gersner s.n. (5) PRE; 3520 (4) PRE; 3934 (5) PRE. Gibbs Russell 3493A (6a) BOL, GRA, PRE, UFH. Giffen 342 (6a) GRA, PRE, UFH. Gilbert 7593 (2) PRE. Gillies 60 (4) NU. Glen 380 (6a) NBG; 2444 (4) PRE. Gordon-Gray 887 (4) NU. Goulins s.n. (6a) BOL. Grice s.n. (4) NU, (6a) NU. Grobbelaar 2618 (1) PRE.

Hepburn 125 (6a) GRA. Hilger 7 (6a) PRE. Hilliard 1778A (4) NU; 2648, 3031 (6a) NU; 4708, 8165 (4) NU; 8228 juvenile (5) NU. Hilliard & Burr 6532 (6a) K, NU, PRE; 9314 (4) NU; 12481, 12581, 13284 (6a) NU; 13285 (6a) K, NU; 13331 (8) NU; 13341 (5) NU; 13342 (1) NU; 13416 (4) NU, PRE; 13428 (5) NU; 13442 (4) K, NU; 13465 (8) NU; 13508, 13513 (4) NU; 13561 (2) K, NU, PRE; 13563 (5) NU; 13592 (4) K, NU; 13653 (4) K, PRE; 13689 (5) NU; 13865 (6a) K, NU; 13866 (6a) K, NU, PRE; 13894 (6a) NU; 14011 (4) NU; 14035 (6a) NU; 14071 (8) K, PRE; 14292 (8) K, NU, PRE; 14323 (1) NU, PRE; 14383 (8) K, NU, PRE; 14459 (8) K, NU; 14502, 14503 (6a) NU; 14506 (6a) K, NU; 14510 (6a) K; 14655 (6a) K, NU, PRE; 14753 (6a) K, NU; 14887 (4) NU; 14888 (5) NU, PRE; 14925 (6a) NU, PRE; 14965 (4) NU; 15021 (2) K, NU; 15105 (4) K, NU, PRE; 15172 (4) NU, PRE; 15266 (1) K, NU, PRE; 15378 juvenile (5) K, NU; 15397 (4)



FIGURE 12.—Known distribution of *Cliffortia erectisepala*, ■, and *Cliffortia repens*, ▲, in southern Africa.

K, NU, PRE; 15403, 15430 (8) K, NU, PRE; 15447 (5) K, NU, PRE; 15456 (3) K, NU; 15505 (5) NU; 15510 (5) NBG, NU; 15542 (5) NBG; 15591 (6a) NU; 15592 (4) NU; 15634 (8) K, NU, PRE; 15643 (6a) K, NU, PRE; 15644 (6a) NU, PRE; 15667, 15672 (4) NU; 15673 (4) K, NU; 15789 (5) K, NU, PRE; 15790 (4) K, NU, PRE; 15815 (4) NU; 15816 (5) NU, PRE; 16273 (8) K, NU, PRE; 16274 (5) NU; 16286 (4) K, NU, PRE; 16304 (3) K, NU; 16332 (6a) K, NU, PRE; 16333 (6a) K, NU; 16422 (2) K, NU, PRE; 16489 juvenile (5) NU; 16605 (2) K, NU; 16762 (8) K, PRE; 16870, 16871 (4) K, NU, PRE; 16986 (8) NU; 16987 (4) NU; 17012 (4) K, NU, PRE; 17025 (8) K, NU, PRE; 17030 (4) K, NU, PRE; 17077 (6a) NU, PRE; 17095 (6a) K, NU, PRE; 17110 (4) NU; 17169 (8) K, NU, PRE; 17225 (1) K, NU, PRE; 17667 juvenile (5) K, NU, PRE; 17668 (8) K, NU, PRE; 17677, 17681 (1) K, NU, PRE; 17697 (3) K, NU, PRE; 17724 (8) K, NU, PRE; 17761, 17805 (4) NU; 17955 (6a) NU, PRE; 17956 (4) K, NU; 17994 (1) NU; 18058, 18180 (5) NU; 18284 (5) K, NU, PRE; 18315 juvenile (5) NU; 18329 (6a) K, PRE; 18330 juvenile (5) K, NU, PRE; 18358 (8) K, NU, PRE; 18336 juvenile (5) K, NU, PRE; 18681 juvenile (5) NU; 18837 (6a) K, NU, PRE. Hilliard, Burt & Manning 15955 (6a) NU; 15965 (4) NU, PRE; 16026 (1) K, PRE; 16061, 16062 (1) NU; 16069 (6a) NU; 17261 juvenile (5) NU; 17296 (4) NU. Huntley 409 (5) NU. Hutchinson 4534 (8) K; 4543 (5) K; 4550 (3) K; 4580 (2) K. Hutchinson & Gillett 4314 (8) K. Hutchinson, Forbes & Verdoorn 72 (3) PRE.

Jacobsen 2272 (8) PRE. Jacot-Guillarmod 3958 (6a) PRE; 7959 (6a) GRA. Jacot-Guillarmod, Getliffe & Mzamane 218 (1) GRA. K, PRE. Johnstone 209 (6a) NU. Jordaan 2910 (1) PRE.

Keet STE13384 (6b) NBG, (8) NBG. Kemp 1223 (8) PRE. Kensit & Coporn in NBG. 150/14 (6b) BOL. Kerfoot, Forrester & Gooyer 31 (8) PRE. Killick 1109 (8) K, PRE; 1932 (3) PRE. Killick & Vahrmeyer 3711 (6a) K, PRE. Kluge 2313 (8) NBG, PRE. Krynanaw 310 (8) PRE; 782 (1) PRE. Kuntze s.n. (5) K.

Lambinon & Reekmans 82/460 (8) PRE. Leighton 2697 (6a) BOL; 2998 (6a) BOL, PRE; 3127 (6a) BOL; 3267 (8) BOL. Levyns 6905 (6a) BOL; 8240 (4) BOL; 8267, 8273 (8) BOL; 8302 (5) BOL; 8303 juvenile (5) BOL; 8308, 9408 (8) BOL; 9410 juvenile (5) BOL; 9842, 9856 (6a) BOL; 10482 (6b) BOL.

MacDevette 1574 (6a) PRE. Martin 9067 juvenile (5) GRA. McClean & Bayer 5 (8) BOL, K, NU, PRE; 103 (5) NU. McDonald 88 (6b) PRE; 240 (8) K, NU, PRE. Medley Wood s.n. (8) BOL; 4449 (8) K; 4578 (3) K; 5987 (8) K; 7903 (6a) BOL, K. Meeuse 9981 (1) PRE. Meyer 58 (8) PRE. Morris 441 (5) NU. Mudd s.n. (8) BOL, K.

Nel 221 (8) NBG, PRE. Naser NF1969 (4) PRE. Ngwenya 953 (6a) PRE.

Onderstall 170 (1) PRE. Ons s.n. (8) NBG.

Palmer 1412 (6a) GRA. Phillips s.n. (6a) NU; s.n. (5) NU; s.n. (8) NU. Pole Evans 967, 968 (8) K, PRE. Prior 60 (8) K.

Rehmann 6927 (5) K. J. & B. Rennie 168A, 168B (6a) GRA. M. Rennie 120 (4) NU. Roberts 2496 juvenile (5) PRE; 2676 juvenile (5) PRE. Rogers 21565 (8) K; 21591 (8) BOL, K; 22985 (1) BOL, K. Ross 195 (8) NU; 1755 (8) K, NU, PRE. Ruch 2039 (4) K. Rudatis 2063 (6a) NBG.

Scharf 1317 (6b) PRE. Schelpe 440 (4) NU; 673 (5) NU; 1092 (4) NU; 1381 (2) NU, PRE; 7195 (8) BOL, PRE. Schlechter 3318 (4) BOL, K; 5992 (6b) K, PRE; 6494 (8) BOL, PRE. Schmitz 9223 (6a) NU, PRE. Sidey 2015 (2) PRE. Sim 19430 (6a) NU, PRE; 19431 (4) PRE; 19432 (4) NU, PRE. Skead 23 (4) NU. Smit 631 juvenile (5) PRE. Stayner in Herb. Bolus 19865 (6a) BOL. Strey 3116 (6a) PRE; 3190 (6a) GRA, PRE; 4003 (8) GRA. K, PRE; 5448 (8) K, PRE. Strey 6933 (6a) NU, PRE; 7692 (4) K, NU; 11272 (5) NU. Sutherland s.n. (6a) K.

Taylor 4451 (6b) K, NBG, PRE. H. Thode 1598 (8) K. J. Thode 3286, 4330 (8) NBG; 4595 (5) NBG; 6356 (8) NBG. Van Daalen 121 (6b) NBG, PRE. Van der Schijff 1480 (1) K; 4480 (1) PRE; 5588 (1) K, PRE. Van der Schut 4475 (8) K. Van der Walt 367 (6a) PRE. Victor 767 (6a) GRA; 1238 (6a) PRE. Von Gadow 472 (6a) GRA.

Wager 181 (8) K, PRE. Werdermann & Oberdieck 2181 (8) K, PRE. C. & A. Whitehouse 56 (6a) BOL; 286 (2) BOL; 287 (3) BOL; 289 (1) BOL; 290 (8) BOL; 291, 292 (4) BOL; 296 (1) BOL; 297 (6a) BOL; 298 (6b) BOL; 299 (8) BOL; 323 (6a) BOL; 325 (2) BOL; 326 (1) BOL. Wilkinson s.n. (2) GRA. Williams 342 (6a) PRE. Wilms 595 (8) K. Wirringhaus 982 (5) NU; 1054 (4) NU. Wylie in Medley Wood 10029 (8) K.

## ACKNOWLEDGEMENTS

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## Two new species of *Erica* (Ericaceae); one from Western Cape and one from KwaZulu-Natal, South Africa

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**Keywords:** *Erica* L., KwaZulu-Natal, new species, South Africa, taxonomy, Western Cape

### ABSTRACT

Two new species of *Erica* L. from South Africa are described. *E. jananthus* E.G.H.Oliv. & I.M.Oliv. is confined to a single peak in the eastern Groot Swartberg Range in Western Cape and usually forms a small, gnarled, woody, shrublet growing in rock crevices with sticky white flowers and black subexserted anthers that have obtrullate decurrent appendages. *E. psittacina* E.G.H.Oliv. & I.M.Oliv. is from KwaZulu-Natal. It forms large woody shrubs with numerous bright pink flowers and occurs as a single population on a mountain near Creighton. Both descriptions are accompanied by line drawings and distribution maps.

1. *Erica jananthus* E.G.H.Oliv. & I.M.Oliv., sp. nov., fruticulo plerumque parvo lignoso plectile, foliis 3-natis, foliis bractea bracteolis sepalibusque glandibus marginalibus sessilibus fulvis ad brunneis, corolla urceolata viscida lobis effusis ad recurvatis, antheris 8 subexsertis calcaribus decurrentibus anguste ad equilateriliter obtrullatis et irregulatiter denticulatis, ovario viloso 4-loculare ovulis 6–8, seminibus parietibus anticlinilibus percrassis dignoscenda. Figura 1.

**TYPE.**—Western Cape, 3322 (Oudtshoorn): Great Swartberg, eastern end, Snyberg, peak just WNW of beacon, 1 570 m, (–BD), 16 November 2001, *Oliver 11986* (NBG, holo.; BM, K, MO, NY, PRE).

Shrublet compact to loose, 20 × 30–100 × 150 mm, usually woody, single-stemmed. *Branches:* numerous main branches ± 10 mm long, leafy with occasional leafy side branchlets 2–5 mm long; stems puberulous to sparsely strigose with some glands admixed. *Leaves* 3-nate, erect-spreading to patent, elliptic to narrowly lanceolate, 1.5–1.7 × 0.5–0.7 mm, rounded to flattened adaxially and rounded abaxially, sparsely puberulous on both surfaces to almost glabrous adaxially, sulcus narrow and open at base, margins rounded with yellowish to pale brown sessile glands and one apical gland, often completely glabrous when older; petiole adpressed, 0.4–0.5 mm long, edged with short hairs and subsessile to sessile glands. *Inflorescence:* 1–3 flowers in a single whorl at ends of leafy, short, main branches and occasional lateral branchlets, the latter sometimes aggregated at ends of main branches; pedicel ± 2.4 mm long, sparsely and shortly strigulose with longer and stouter gland-tipped hairs or sessile glands admixed; bract partially recaulescent in lower quarter of pedicel, elliptic, ± 0.9 × 0.5 mm, sparsely puberulous ciliate with yellowish to pale brown sessile glands, white sometimes tinged green; bracteoles 2 in mid position, slightly obovate, otherwise like bract. *Calyx* 4-partite; lobes adpressed to corolla, elliptic to

broadly so, ± 1.5 × 1.0–1.2 mm, glabrous, edged with numerous sessile glands, white with narrowly sulcate green apex. *Corolla* 4-lobed, globose urceolate, ± 3.0 × 2.5 mm, glabrous, viscid, white; lobes broadly ovate, ± 1 × 1.5–2.0 mm, spreading to recurved, obtuse or emarginate, minutely and irregularly toothed. *Stamens* 8, free; filaments 1.8–2.0 × 0.2–0.3 mm, linear, curved, glabrous; anthers subexserted, bilobed appendiculate, thecae ± 0.7 × 0.3 mm and oblong in adaxial view, ± 0.8 × 0.4 mm and elliptic in lateral view, golden brown to red-brown, pore ± 1/2 length of theca, appendages decurrent on filament, ± 0.3 × 0.2 mm, narrowly to equilaterally obtrullate, pendulous, irregularly denticulate, pale brown to cream-coloured; pollen shed in tetrads. *Ovary* 4-locular, globose to depressed globose, 0.5–0.9 × 0.9 mm, obtuse to almost flat apically, villous, white to pale green, with well-developed, dark nectaries around base; ovules 6–8 per locule, pendulous from apical placenta; style exserted, narrowly cylindric, slightly curved, ± 3 mm long, white, glabrous; stigma simple-truncate to slightly capitellate, dark green. *Fruit* a dehiscent capsule ± 1.9 × 2.6 mm, valves opening full length, septa equal on valves and columella. *Seeds* ± ellipsoid, ± 0.7 × 0.35 mm, sometimes curved, with flattened micropilar end; testa alveolate, cells ± 100 × 16–20 µm, anticlinal walls unequally undulate and considerably thickened, periclinal walls with scattered pits. Figure 1.

**Diagnostic features:** small, woody, gnarled shrublet; leaves 3-nate; leaves, bract, bracteoles and sepals edged with yellow to brown sessile glands; corolla urceolate, viscid white with spreading to recurved lobes; anthers 8 subexserted with appendages decurrent on filament, narrowly to equilaterally obtriangular and irregularly denticulate; ovary 4-locular with 6–8 ovules per locule, villous; seeds with considerably thickened, unequally undulate, anticlinal walls.

*Erica jananthus* is an isolated species with no clear indications of its relationships. With the 3-nate leaves, marginal glands on the bract, bracteoles and sepals producing a viscid corolla, it would appear to lie within the group in §*Pachysa* that has several species frequenting the mountains in and around the Little Karoo—*E. formosa* Thunb., *E. spectabilis* Klotzsch ex Benth., *E. trag-*

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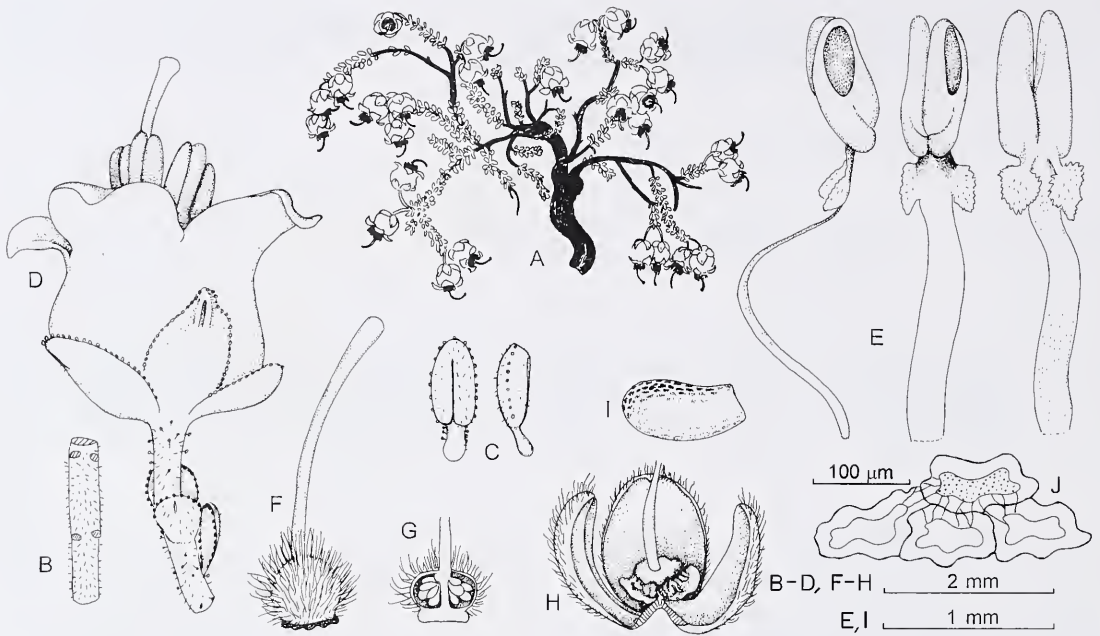


FIGURE 1.—*Erica jananthus*. A, flowering branch, natural size; B, stem; C, leaf, back and lateral views; D, flower; E, stamen, lateral, front and back views; F, gynoecium; G, ovary, opened laterally to show placentation; H, capsule with one valve removed; I, seed; J, testa cells. All drawn from the type, *Oliver 11986*. Scale bars: B–D, F–H, 2 mm; E, I, 1 mm; J, 100  $\mu$ m. Artist: Inge M. Oliver.

*ulifera* Salisb., *E. glomiflora* Salisb., *E. zwartbergensis* Bolus, *E. andreaei* Compton. In those species, however, the anthers are very different with their long thick hairs and narrower appendages, although the latter are often decurrent along the upper part of the filament, and villous ovary. We recently described *E. dolfiana* E.G.H.Oliv. (Oliver & Oliver 2001) from the nearby Blesberg. It has marginal glands on the above-mentioned organs but these are stalked and dark red.

This new species was brought to our attention by the botanist, Jan Vlok of Oudtshoorn, when doing a survey of that part of the Groot Swartberg. The epithet for this new species recognizes his considerable contribution to the recording of plant species and distributions in the mountains surrounding the Little Karoo, *jananthus* = Jan's flower (Latin), there already being *E. vlokii* E.G.H.Oliv. from the Meiringspoort, Kammanassie and

Herold areas (Oliver 2000). We have described several new species of *Erica* from the Swartberg in the Meiringspoort area: *E. dolfiana* E.G.H.Oliv., *E. ingeana* E.G.H.Oliv., *E. vlokii* E.G.H.Oliv., *E. lithophila* E.G.H.Oliv. & I.M.Oliv., *E. jugicola* E.G.H.Oliv. & I.M.Oliv. and *E. umbratica* E.G.H.Oliv. & I.M.Oliv.

The species is as far as we know confined to the Snyberg peaks in the eastern part of the Groot Swartberg Range east of Meiringspoort (Figure 2). There it grows only in rock crevices on south-facing, small, rocky ridges and outcrops in shade for most of the day. A single plant growing in the ground at the base of one ridge was more shrubby, thinner stemmed and up to 300 mm tall. The species does not occur further west on the peaks around Blesberg but there are several peaks to the east of Snyberg that have never been explored botanically.

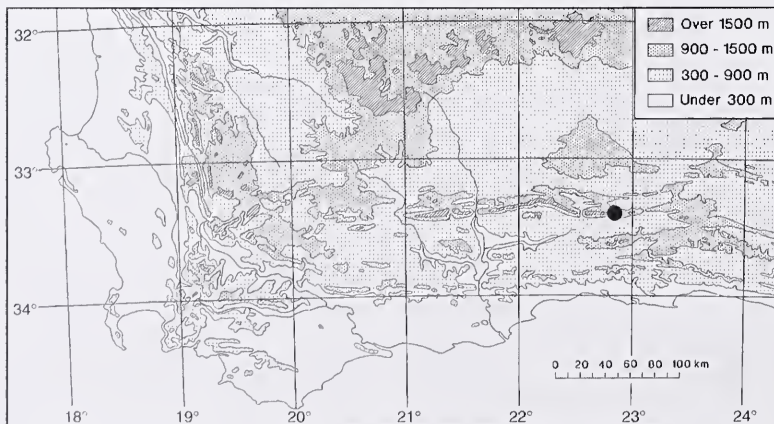


FIGURE 2.—Known distribution of *Erica jananthus*.



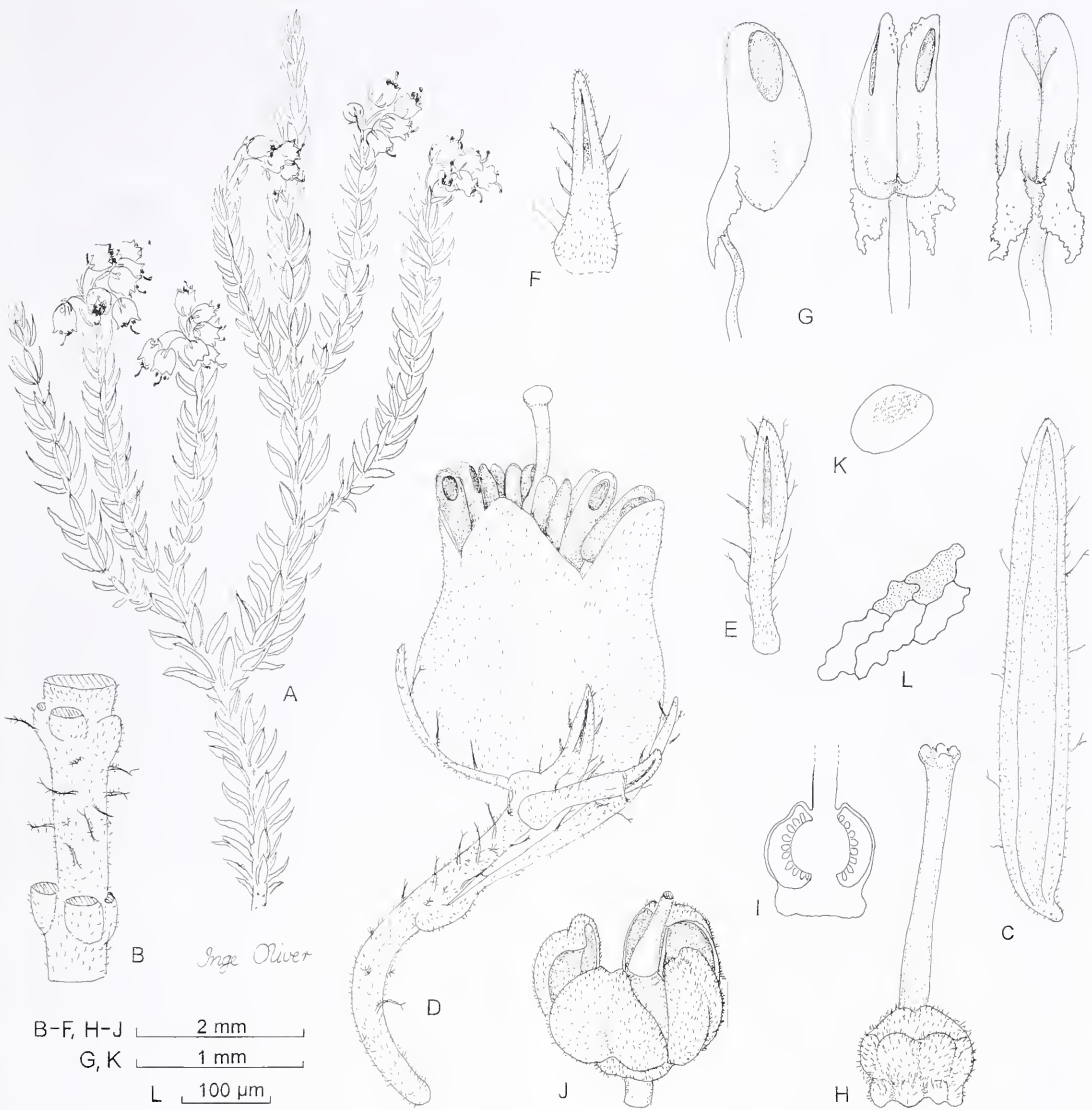


FIGURE 3.—*Erica psittacina*. A, flowering branch, natural size; B, stem with leaves removed; C, leaf; D, flower; E, bracteole; F, sepal; G, anther, lateral, front and back views; H, gynoecium; I, ovary, l/s showing placenta and ovule positions; J, capsule; K, seed; L, testa cells. All drawn from the type, *Oliver & Turner 12167*. Scale bars: B–F, H–J, 2 mm; G, K, 1 mm; L, 100 µm. Artist: Inge Oliver.

No pollinators were noted when the type collection was made. Pollination is presumed to be carried out by flying insects because of the presence of nectaries and the reduced size of the stigma. Crawling insects would encounter problems with the viscid corolla.

#### Paratype material

WESTERN CAPE.—3322 (Oudtshoorn): Great Swartberg Mtns, Snyberg, 1 500 m, (–BD), 22-08-1990, *Vlok 2377* (NBG); *ibid.*, 11-03-1991, fruiting, *Vlok 2453* (NBG); *ibid.*, 12-11-1991, *Vlok 2533* (NBG, PRE).

2. *Erica psittacina* E.G.H.Oliv. & I.M.Oliv., sp. nov., frutice magno lignoso ad 2 m raro 3 m alto uniucauli, foliis 4-natis, inflorescentibus parte inferiore racemosa superiore umbelliformi, corolla subtiliter breviterque pubescenti clarorosea, indumento in partibus multis pilis

brevissimis cum pilis paucis crassis plumosis apice furcato dignoscenda. Figura 3.

TYPE.—KwaZulu-Natal, 2929 (Underberg): Creighton, Hlabeni, steep southeast-facing slopes below summit ridge, 1 662 m, (–DC), 4 February 2003, *Oliver & Turner 12167* (NBG, holo.; BM, CPF, K, NH, NU, NY, PRE).

Shrub woody, bushy, erect, 1.0–1.5(–2.0)[–3.0] m tall, single-stemmed. *Branches*: main branches up to 400 mm long, sometimes topped with numerous vegetative secondary branches or just flowering secondary branches; secondary branches numerous, 100–160 mm long, with 1 or 2 tertiary branches 30–60 mm long; stem with dense, short, simple hairs and spreading to reflexed, stouter, longer hairs admixed, these mostly shortly plumose mainly towards base of hair and sometimes with longer

forked tips; internodes 2–5 mm long. *Leaves* 4-nate, suberect to spreading but curved upwards, occasionally reflexed at base of secondary branches, lanceolate,  $\pm 7 \times 1$  mm, with rounded margins, partially open-backed with sulcus open at base, with fine, short, simple hairs and a few, long, stouter, fork-tipped hairs, these sometimes shortly plumose at base; petiole  $\pm 1$  mm long, with sparse, short, simple hairs; on margins a few shortly stalked glands. *Inflorescence*: flowers 4-nate in 2–5 whorls, terminal on secondary branches, rarely tertiary branches, lower 1 or 2 whorls with internodes, upper whorls umbel-like; pedicel 4–6 mm long, with dense, fine, simple hairs and sparse, long, stout, spreading, plumose hairs admixed, red; bract leaf-like and on branch in lower whorls of inflorescence to partially recalcrescent in mid position in upper whorls; bracteoles 2, lanceolate,  $\pm 3 \times 0.4$  mm, green, base pinkish, placed  $\pm \frac{2}{3}$  way up pedicel, indumentum like bract. *Calyx* 4-partite; segments lanceolate,  $\pm 2.5\text{--}3.0 \times 0.5$  mm, finely hairy plus long, stout hairs on margins, the upper terminally forked, the lower also shortly plumose towards base, acute or attenuated into a long, plumose seta; upper half of segments green, lower pink, sulcus  $\pm \frac{1}{2}$  length of segment. *Corolla* 4-lobed, globose-urceolate,  $\pm 4 \times 3.5$  mm, finely puberulous, pink; lobes suberect,  $\pm 0.8 \times 1.5$  mm, rounded, entire. *Stamens* 8, manifest; filaments  $\pm 3$  mm long, straight; anthers basifixed, bilobed, oblong in front view, appendiculate, orange-brown; thecae erect adpressed, oblong,  $\pm 1.0\text{--}1.3 \times 0.5$  mm in lateral view, aculeate, pore  $\pm \frac{1}{2}$  length of theca, appendages  $\pm 0.7$  mm long,  $\pm$  ovate-elliptic, flattened, irregularly shallowly and deeply toothed, yellow; pollen in tetrads. *Ovary* 4-locular, depressed globose-obovoid, emarginate,  $\pm 1.2 \times 1.5$  mm, covered with simple, short hairs, with large nectaries around base; ovules  $\pm 50$  per locule, spreading from bulbous placenta on upper  $\frac{2}{3}$  of columella; style  $\pm 4$  mm long, exserted; stigma capitate. *Fruit* a dehiscent capsule,  $\pm 1.8 \times 2.3$  mm, valves spreading to  $45^\circ$  but curved-erect, split to base, septa only on valves. *Seeds* ellipsoid-ovoid,  $\pm 0.5 \times 0.25$  mm, sometimes angled, very shallowly alveolate, yellow-brown to brown; testa cells oblong,  $\pm 50\text{--}100 \times 25\text{--}35$   $\mu\text{m}$ , anticlinal walls undulate to irregularly slightly jigsawed, slightly thickened, periclinal walls finely pitted. Figure 3.

*Diagnostic features*: large, woody, single-stemmed shrub, mostly 1.0–1.5, occasionally up to 2, rarely 3 m tall; leaves 4-nate; flowers in inflorescences of racemose lower and umbel-like upper whorls; bract leaf-like and non-recalcrescent in lowest whorls to reduced and partially recalcrescent in the middle position in the uppermost whorls; corolla finely and shortly hairy, bright pink; indumentum on stems, leaves, pedicel, bract, bracteoles and sepals finely and densely hairy with simple hairs and some long, stout hairs admixed, these shortly and sometimes densely plumose, mainly towards the base and often with longer, forked tips.

*Erica psittacina* is a very distinct species among the 32 *Erica* species that occur in KwaZulu-Natal. Its relationships with these species is not clear. Within the group of species having 4-nate leaves, it is perhaps most similar to *E. algida* Bolus which is widespread along the whole Drakensberg Range but that differs in being a multi-stemmed resprouter, and having the flowers in a

single inflorescence arranged in one whorl and with partially recalcrescent bract. Similarly most of the remaining KwaZulu-Natal species with 4-nate leaves have the wrong type of inflorescence and only a partially recalcrescent bracts. However, the 4-nate *E. revoluta* L.E.Davidson has the racemose inflorescence but without the terminal umbel and the bract varies similarly from its axial position to partially recalcrescent. The shrub is usually large and woody with a similar indumentum in most parts and the leaves are partially open-backed, but it differs in the glabrous corolla and the reduced, partially fused calyx.

The plants are very vigorous growers. With old flowers from the previous flowering season often still remaining on some branches, the annual growth increment is easily assessable. In many cases it is as much as 200 mm, rarely to 300 mm. This characteristic is reminiscent of the plants in the type population of *E. oakesiorum* E.G.H.Oliv. from Western Cape (Oliver & Oliver 1996) in which the growth can be as much as 400 mm in one season.

*E. psittacina* is the most restricted species in the province, occurring only in a remarkably small area on Hlabeni Mountain above Creighton in the KwaZulu-Natal Midlands (Figure 4). There it grows on a steep southeast-facing slope in a long, relatively narrow belt of dense, indigenous, shrubby vegetation up to 4 m tall, consisting mainly of *Tarchonanthus camphoratus* and along the upper limits, species of *Passerina*, *Protea* and *Cliffortia*. The slope is composed of large boulders and rocky outcrops. Below that belt there is a pristine stand of tall indigenous forest above vast tracts of exotic pine plantations. The summit of Hlabeni is covered in well-grazed and burnt, short grassland.

It is estimated that there are up to 100 plants of *E. psittacina* in this extended population. The shrubs vary in height from 1 m tall in more exposed open places to almost 2 m tall and rarely taller in the denser stands of vegetation. They are mostly scattered plants that are easily noted due to their abundant pink flowers contrasting against the otherwise drab vegetation. Access to many of the plants is very difficult due to the nature of the terrain and density of the vegetation. In those that could be examined closely it was

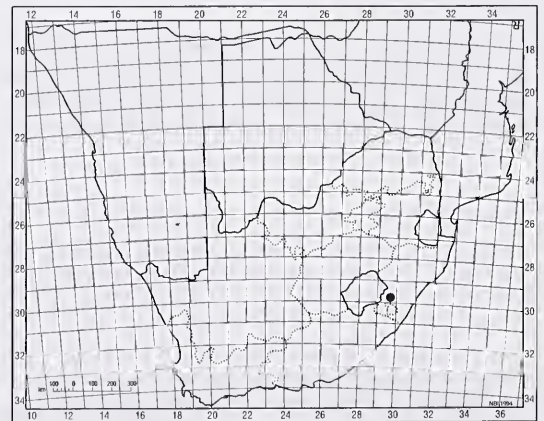


FIGURE 4.—Known distribution of *Erica psittacina*.

noted that the plants are single-stemmed with a trunk up to 100 mm in diameter. The vegetation appeared to be very old and not affected by the frequent fires that must sweep the summit plateau, perhaps being protected by a wind shadow. From below, the habitat is protected by the dense, tall belt of indigenous forest.

The flowers were seen to be visited by a few honey bees. This corresponds with large nectaries around the base of the ovary, the exerted stigma which with slightly enlarged and the partially exerted anthers, in strongly suggesting an insect pollination syndrome for the species. A slight scent was noticeable from the fresh flowers in the wild. It was, however, not possible to see whether the bees came for nectar or just pollen.

The epithet for this new species honours the very distinguished and rare inhabitant of Hlabeni, the Cape parrot, *Poicephalus robustus (psittacinus* = belonging to, possession of, the parrot). The plants were discovered there by our daughter and two molecular systematists from Stellenbosch University who were visiting the mountain in 2002 to sample the orchids. The indigenous forests above which the erica grows is inhabited by a remnant population of Cape parrots. It was through the assistance of the local conservationist and parrot enthusiast,

Malcolm Gemmel, that they and ourselves visited the mountain.

#### *Paratype material*

KWAZULU-NATAL.—2929 (Underberg): Creighton, Hlabeni, ± 1 680 m, (–DC), 24-01-2002, *T.A. Oliver* 8 (NBG).

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## Two new species of *Romulea* (Iridaceae: Crocoideae) from the western Karoo, Northern Cape and notes on infrageneric classification and range extensions

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**Keywords:** Iridaceae, new species, *Romulea collina* J.C.Manning & Goldblatt, *Romulea eburnea* J.C.Manning & Goldblatt, South Africa, taxonomy

### ABSTRACT

Two new species of *Romulea* are described from Northern Cape, raising the number of species in southern Africa to 76. *R. collina* J.C.Manning & Goldblatt is endemic to the Hantamsberg near Calvinia. It is distinguished in subgenus *Spatalanthus* by its clumped habit, yellow flowers with dark markings in the throat, and short papery bracts. A re-examination of relationships within the subgenus suggests that section *Cruciatae* is not monophyletic and it is accordingly no longer recognized as separate from section *Spatalanthus*. *R. eburnea* J.C.Manning & Goldblatt is a distinctive species of subgenus *Spatalanthus* from the Komsberg near Sutherland. It is distinguished by its golden yellow flowers with the apical third of the tepals coloured pale creamy apricot, bracts with broad, translucent margins and tips, and an unusually long perianth tube, 10–13 mm long.

The genus *Romulea* (Iridaceae: Crocoideae) comprises  $\pm 90$  species in sub-Saharan Africa, the Mediterranean and Near East. The centre of diversity of the genus lies in the winter rainfall region of southern Africa, where 73 species are currently recognized (Manning & Goldblatt 2001). The most recent revision of the sub-Saharan species divides the genus into two subgenera and six sections, based largely on characters of the corm (Manning & Goldblatt 2001). The fine structure of the corm provides essential information for accurate identification of many species, since the flower structure, with few exceptions, is conservative (Goldblatt *et al.* 2002).

Five new species of *Romulea* have been described from South Africa in the twenty years since the publication of De Vos's (1972) monograph of the genus in southern Africa (De Vos 1983; Manning & Goldblatt 2001). The subsequent discovery of an undescribed species from the summit plateau of the Hantamsberg near Calvinia in Northern Cape, described here as *Romulea collina*, and a second from the Klein Roggeveld south of Sutherland, described as *R. eburnea*, now raises the total number of species in southern Africa to seventy six. Both new species are members of subgenus *Spatalanthus*, defined by the outer corm tunics splitting below into prominent, recurved or straight teeth without fibrous tips (Manning & Goldblatt 2001). The Roggeveld Escarpment is well known for the diversity of its endemic geophyte flora (Manning *et al.* 2002) and is the centre of diversity for subgenus *Spatalanthus*. Over half of the twenty five known species of the subgenus are endemic to the Roggeveld and adjacent Bokkeveld Escarpments (Manning & Goldblatt 2001) and the description of two new species brings the total number of endemic *Romulea* species in this centre to fifteen.

The discovery of *Romulea collina* raises doubts as to the validity of the distinction between the two sections *Cruciatae* and *Spatalanthus* of subgenus *Spatalanthus*, recognized by Manning & Goldblatt (2001) in their recent account of the genus. This distinction is re-examined and we conclude that the recognition of section *Cruciatae* is no longer justified.

***Romulea collina* J.C.Manning & Goldblatt, sp. nov.**

TYPE.—Northern Cape, 3119 (Calvinia): summit of Hantamsberg at base of radio mast, (–BD), August 2002, flowered in cult., July 2003, *IBSA 5 (NBG195425, holo.)*.

Plantae 50–100 mm altae caespitosae, caule subterraneo ad 4-ramoso, ramis ad 10 mm supra terram productis, cormo subgloboso asymmetrico base rotundo, tunicis infra divisis cuspis acuminatis recurvatis supra fibris grossis 20–40 mm longis, foliis 7–9 laminis ad 50–100 mm longis, floribus solitariis, bracteo externo subobtusos pallide papyraceo ad apicem marginibus apiceque latis translucentibus brunneo vittato 10–12 mm longo interno obtuso pallide papyraceo, floribus profunde cupuliformibus pallide flavis cupulo luteo, tubo perianthii infundibuliforme 4 mm longo parte inferiore  $\pm 1$  mm longo, tepalis lanceolatis  $\pm 20 \times 7$  mm, staminibus flavis filamentis  $\pm 6$  mm longis dense pubescentibus in dimidio inferiore, antheris 2.5–3.0 mm longis apiculatis, ramis styli 1.5–2.0 mm longis, capsulis subglobosis  $\pm 8$  mm oblongo-ovoideis pedicibus recurvatis.

Plants 50–100 mm high, growing in clumps; stem subterranean, with up to four branches reaching 10 mm above-ground, these relatively stout and flushed maroon. *Corm* subglobose, asymmetric, base rounded, tunics split into curved acuminate teeth below, drawn into coarse fibres above, these 20–40 mm long. *Cataphylls* 3, flushed maroon above ground. *Leaves* 7–9, all basal, sheaths flushed deep purple, blades two to four times as long as flowering stems, narrowly 4-grooved, 50–100  $\times$  1.0–1.5 mm. *Inflorescence*: up to 4 solitary flowers;

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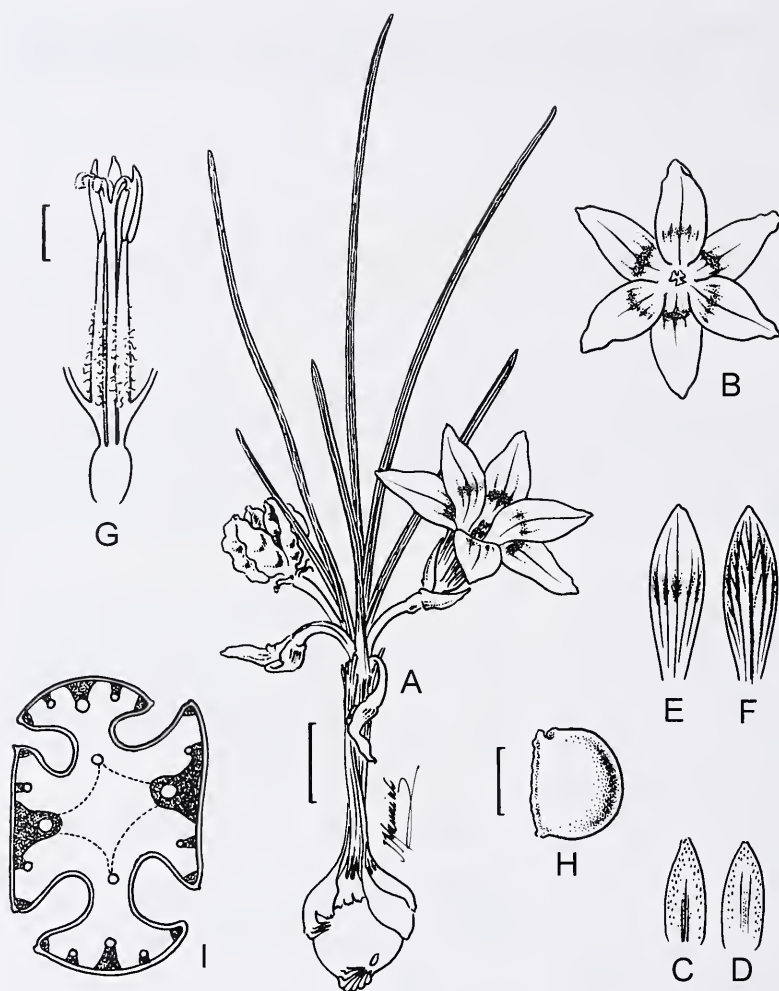


FIGURE 1.—*Romulea collina*. A, whole plant; B, flower; C, outer bract; D, inner bract; E, adaxial markings on outer tepal; F, adaxial markings on inner tepal; G, stamens and style; H, seed; I, t/s leaf. Scale bars: A–F, 10 mm; G, H, 2 mm. Artist: John Manning.

outer bracts subobtusate, pale and papery throughout with veins in centre pale green, with broad, translucent margins and tip flecked pale brown, 10–12 mm long; inner bracts obtuse, pale and papery throughout with only main veins pale green, with broad translucent margins flecked pale brown, about as long as outer. *Flowers* deeply cup-shaped, cup  $\pm$  11 mm deep, pale canary yellow with golden yellow cup; outer tepals with dark median blotch or transverse zone in throat, reverse marked with dark maroon longitudinal streaks; inner tepals with narrow brownish maroon median line and diffuse transverse zone in throat, unscented,  $\pm$  30 mm diam.; perianth tube funnel-shaped, 4 mm long with lower narrow portion  $\pm$  1 mm long, tepals lanceolate,  $\pm$  20  $\times$  7 mm. *Stamens* yellow; filaments inserted at base of cup, free, densely hairy in lower half, 6 mm long; anthers apiculate, parallel, 2.5–3.0 mm long. *Style* dividing opposite upper third of anthers, branches 1.5–2.0 mm long, divided for about two thirds of their length. *Capsules* subglobose,  $\pm$  8 mm long, pushed onto soil surface or slightly underground by strongly recurved pedicels which later become erect and 10–15 mm long. *Seeds* subglobose or angled by pressure, reddish brown, 2.5–3.0 mm diam. *Flowering time*: late June to mid-July, possibly to late July. Figure 1.

#### Distribution and ecology

This clump-forming species is known from a single, very localized colony on the summit plateau of the Hantamsberg overlooking Calvinia on the Bokkeveld Escarpment (Figure 2). The plants grow in seasonally moist, dolerite clays in open renosterveld, invariably in small clumps that appear to originate from seeds that are shed directly at the base of the parent plant. The short peduncles curve downwards immediately after flowering but become erect when the fruits mature. They do not, however, elongate appreciably so that the mature capsules dehisce 10–15 mm above the ground at the base of the plant. Flowers open around midday and close in mid-afternoon. They are short-lived, lasting only two days. At up to 3 mm diam., the seeds of *R. collina* are among the largest recorded in the genus, where seeds are mostly 1–2 mm diam. (De Vos 1972).

*Romulea collina* is yet another of several species of Iridaceae that are endemic to the Hantamsberg, an isolated, flat-topped massif representing a northern outlier of the Roggeveld Escarpment. Iridaceae endemic to the slopes and summit of the Hantamsberg include *Hesperantha hantamensis* Schltr. ex Foster, *H. oligantha* (Diels) Goldblatt,

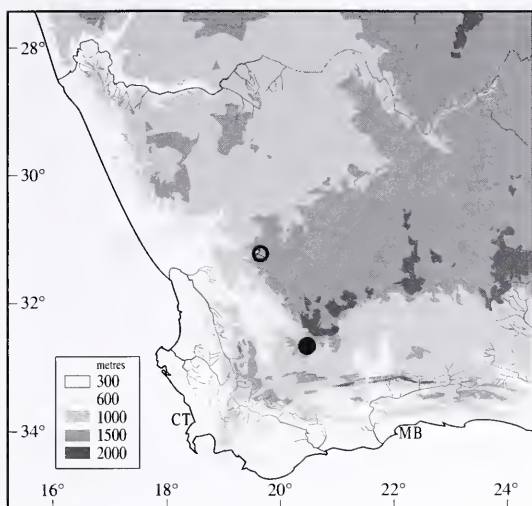


FIGURE 2.—Distribution of *Romulea collina*, ○; and *Romulea eburnea*, ●.

*Moraea reflexa* Goldblatt and *Romulea hantamensis* (Diels) Goldblatt, among others (Van Wyk & Smith 2001).

#### Diagnosis and relationships

*Romulea collina* is readily distinguished by its clumped habit, rounded corm with the outer tunics splitting into acuminate teeth, yellow flowers with dark markings in the throat, and short bracts, 10–12 mm long, that are entirely pale and papery at flowering. The corm with tunics splitting into acuminate teeth at the base are a defining characteristic of *Romulea* subgenus *Spatalanthus* but within the subgenus, the relationships of *R. collina* are more difficult to define. The rounded corm with curved basal teeth is characteristic of section *Spatalanthus* but in other respects, particularly the relatively short, more or less entirely membranous bracts and the long filaments, the species closely resembles *R. membranacea* M.P. de Vos, another species from the Roggeveld Escarpment.

**Conservation status:** Vulnerable (B1 + 2c, D).

Apart from the difference in the corm shape, *R. collina* is separated from *R. membranacea* by the longitudinal dark streaks on the outside of the outer tepals and by the pronounced dark blotches on the inside. Despite their different corm morphology, the overwhelming similarity between the two species in other particulars makes it difficult to accept that they are not immediately related. *R. membranacea* is currently placed in section *Cruciatae*, which is defined by a corm pointed at base and with straight basal teeth (Manning & Goldblatt 2001) but the relationships of this species have always been problematic. De Vos (1972) placed it in her subsection *Atrandrae* on the basis of the broad membranous margins of the bracts but pointed out that it was anomalous here in its pointed corm and lack of marginal veins in the leaves. Manning & Goldblatt (2001), placing greater emphasis on corm structure, preferred to ally it with the other species with straight basal teeth, which it matches in leaf anatomy. The chromosome number  $2n = \pm 24$  is, however, inconsistent with this alliance and accords better with section *Atrandrae*. The discovery of the new species *R. col-*

*lina*, with the rounded corm of section *Spatalanthus* but the leaf anatomy and bract morphology of *R. membranacea*, suggests that the earlier placement by De Vos (1972) of *R. membranacea* in subsection *Atrandrae* (= series *Atrandrae* of Manning & Goldblatt 2001) is preferable. Within series *Atrandrae*, *R. collina* and *R. membranacea* are probably most closely related to *R. diversiformis* M.P. de Vos, with which they share yellow flowers, fruiting peduncles that are curved at maturity rather than coiled, and leaves that lack marginal veins along the furrows.

The reassessment of the relationships of *R. collina* and *R. membranacea* implies that the pointed corm with straight basal teeth has arisen more than once within the genus. If this interpretation is correct then the heterogeneity evident within the section assumes a new significance. Section *Cruciatae* is currently divided into two series. Series *Cruciatae*, with the removal of *R. membranacea*, contains three species, two of which are clearly sister taxa [*R. cruciata* (Jacq.) Baker and *R. eximia* M.P. de Vos] that share the unusual chromosome number  $2n = 18$ . On the basis of their cytology, *R. cruciata* and *R. eximia* are better allied with *R. rosea* (L.) Eckl. (section *Spatalanthus*, series *Roseae*), the only other species in the genus with  $2n = 18$ . The third species in this series, the poorly known *R. vlokii* M.P. de Vos has bracts that more closely resemble those found in series *Atrandrae* of section *Spatalanthus*, which is where De Vos (1983) placed it. Series *Tubiformes* contains a single highly derived species, *R. hantamensis* (Diels) Goldblatt, with a chromosome number  $2n = 30$ , which is unique within subgenus *Spatalanthus* and its relationships remain unclear. If the pointed corm is interpreted as a convergent character state, then it is likely to have evolved three times in section *Cruciatae* and a fourth time in *R. membranacea*. Section *Cruciatae* as currently construed is probably not monophyletic and it seems more appropriate that the species within it be removed to section *Spatalanthus*. Accordingly, we no longer recognize section *Cruciatae*, and subgenus *Spatalanthus* should no longer be subdivided into sections.

***Romulea eburnea* J.C. Manning & Goldblatt, sp. nov.**

**TYPE.**—Northern Cape, 3220 (Sutherland): 28 km along Komsberg Pass road from southern end, foot of Smoushoogte, alluvial wash along Meintjiesplaasrivier, (–DC), 28 August 2003, J. Manning 2886 (NBG, holo.; MO, iso.).

Plantae 100–150 mm altae, caule subterraneo 2-ramoso, ramis ad 30 mm supra terram productis, cormo subgloboso asymmetrico base rotundo, tunicis infra divisus cuspis acuminatis recurvatis supra fibris grossis  $\pm 2$  mm longis, foliis 2–4 laminis ad 150–200 mm longis, floribus solitariis, bracteo externo marginibus translucen-tibus apice membranaceo brunneo vittato 18–22 mm longo interno bifido, floribus profunde cupuliformibus pallide cremeo-armeniaceis supra luteis infra  $\pm 30$  mm diam., tubo perianthii infundibuliforme, 10–13 mm longo parte inferiore 6–8 mm longo, tepalibus lanceolatis, 23–27  $\times$  7–9 mm, staminibus flavis filamentis 6–7 mm longis ad basem pubescentibus, antheris  $\pm 8$  mm longis, ramis styli 3 mm longis, capsulis oblongo-ovoideis 10–11  $\times$  5.5–6.0 mm pedicelibus recurvatis spiralis ubi siccus.

Plants 100–150 mm high; stem subterranean, with up to two branches reaching 30 mm above ground, these relatively stout and flushed maroon. *Corm* subglobose, asymmetric, base rounded, tunics split into curved acuminate teeth below, drawn into coarse fibres above, these up to 2 mm long. *Cataphylls* 3, flushed maroon above ground. *Leaves* 2–4, sheathing portion pale with adhering sand grains, blades of two longest leaves up to six times as long as flowering stems, narrowly four-grooved, 150–200 mm long, when more than two leaves present, then uppermost one or two with blades less than half as long, 10–100 × 1 mm. *Inflorescence*: up to 2 solitary flowers; outer bracts pale reddish brown with broad, translucent margins and broad, membranous tip flecked with pale brown, 18–22 mm long; inner bracts bifid, pale reddish brown with broad, translucent margins and broad, membranous tip flecked with pale brown, about as long as outer or slightly longer. *Flowers* deeply cup-shaped, cup ± 12 mm deep, pale creamy apricot with lower two thirds of tepals and

cup deep yellow; outer tepals with reverse flushed dull olive in centre in lower half, unscented, ± 30 mm diam.; perianth tube funnel-shaped, 10–13 mm long with lower narrow portion 6–8 mm long, tepals lanceolate, 23–27 × 7–9 mm. *Stamens* yellow; filaments inserted at base of cup, free, pubescent at base, 6–7 mm long; anthers suberect or lightly incurved, ± 8 mm long. *Style* dividing opposite tips of anthers, branches 3 mm long, divided for about half their length. *Capsules* oblong-ovoid, 10–11 × 5.5–6.0 mm, pushed onto soil surface or slightly underground by strongly recurved pedicels which later coil up when dry. *Seeds* subglobose or angled by pressure, reddish brown, 1.8–2.0 mm diam. *Flowering time*: late August to early September. Figure 3.

#### *Distribution and ecology*

This distinctively coloured species is known from a single colony below Smoushoogte Pass south of Sutherland at the

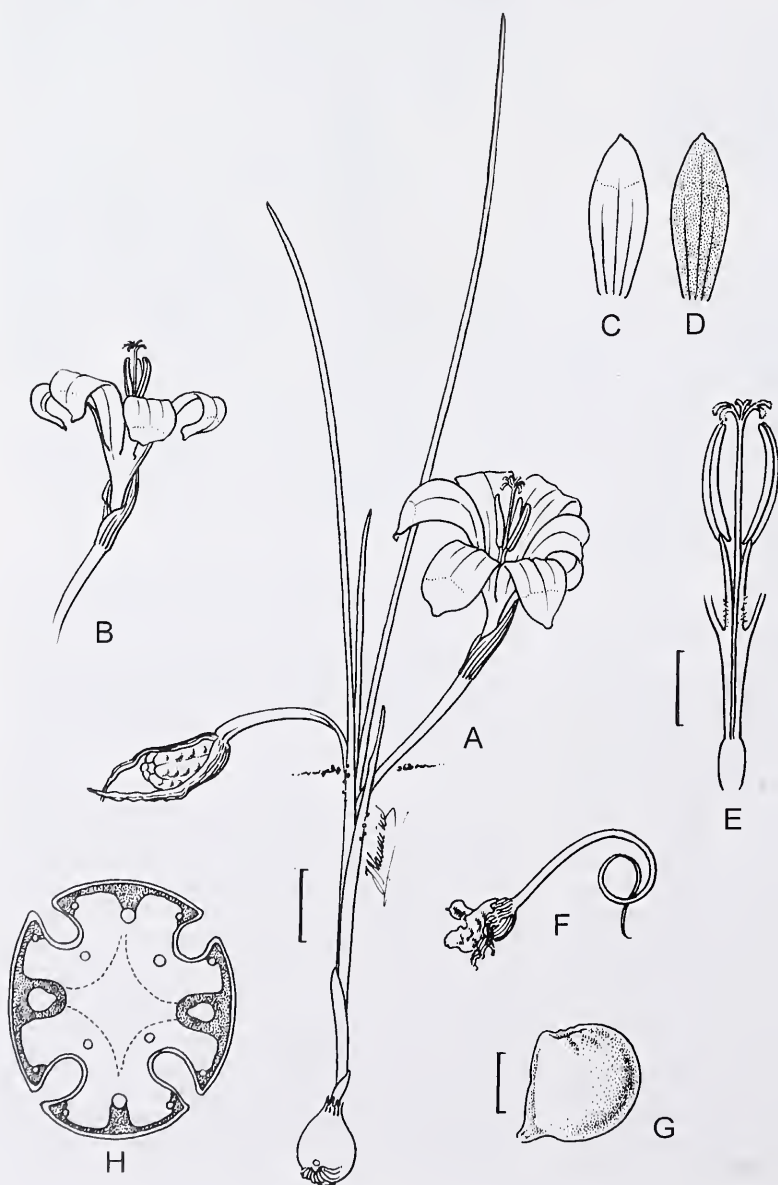


FIGURE 3.—*Romulea eburnea*. A, whole plant; B, flower, side view; C, adaxial markings on outer tepal; D, adaxial markings on inner tepal; E, stamens and style; F, dry capsule; G, seed; H, t/s leaf. Scale bars: A–D, F, 10 mm; E, 5 mm; G, 1 mm. Artist: John Manning.



foot of the Klein Roggeveldberge (Figure 2). *Romulea eburnea* grows in an alluvial wash along the Meintjiesplaasrivier in seasonally moist, deep sandy loam. The vegetation is open scrub dominated by *Asparagus capensis*, *Chrysocoma ciliata*, *Eriocephalus eximius*, and *Dimorphotheca cuneata*, and quite distinct from the adjacent renosterveld (*Elytopappus rhinocerotis*) community that occupies fine-grained clays derived from shale.

*R. eburnea* was first noticed almost a decade ago by local bulb enthusiasts who reported the occurrence of a pale-flowered species on the Komsberg but in the absence of specimens it was impossible to verify its identity. The possibility that it represented an outlying population of *R. membranacea* was suggested by Manning & Goldblatt (2001) but it is now clear that the plants represent a distinct species. It is another of several species in series *Atrandrae* that are endemic or near-endemic to the Roggeveld Escarpment around Sutherland, including *R. hallii* M.P.de Vos, *R. komsbergensis* M.P.de Vos and *R. multifida* M.P.de Vos.

#### Diagnosis and relationships

The rounded corms with tunics fragmenting into curved teeth, place *Romulea eburnea* firmly in subgenus *Spatalanthus*. It is immediately recognized by its largely golden yellow flowers with the apical third of the tepals coloured pale creamy apricot, bracts with broad, translucent margins and tips, and the unusually long perianth tube. This is funnel-shaped and 10–13 mm long with the lower narrow portion 6–8 mm long. In most other species of *Romulea* with a similar-shaped perianth, the tube is 4–6(–10) mm long with the lower narrow portion no more than 2 mm long. Within subgenus *Spatalanthus*, the presence of vascular bundles along the margins of each of the ribs in the leaves, the broad membranous margins and tips to the bracts, and fruiting peduncles that coil when dry, are all consistent with series *Atrandrae*. Within series *Atrandrae*, *R. eburnea* is possibly most closely allied to *R. diversiformis*, with which it shares yellow flowers lacking dark markings in the throat and a long style that divides at or beyond the tips of the anthers. In an extraordinary coincidence, both *R. diversiformis*, described just over fifty years ago (De Vos 1952), and *R. eburnea* share the same type locality and we have in the past collected *R. diversiformis* in flower in late September within a few dozen metres of the *R. eburnea* population, then long past flowering, without being aware of its existence. *R. diversiformis* was until recently thought to be restricted to the Klein Roggeveld area but is now known to occur also on the Hantamsberg near Calvinia, a considerable distance away at the northern end of the Roggeveld Escarpment (Manning & Goldblatt 2001). *R. diversiformis* is distinguished from *R. eburnea* by its greater number of leaves, 6 or more versus 2–4, uniformly golden yellow flowers with short perianth tube, 4–6 mm long versus 10–13 mm long and fruiting peduncles that do not coil up when dry. The two species differ also in leaf anatomy, *R. diversiformis* lacking rib marginal veins but possessing secondary veins in the ribs. *R. diversiformis* grows in fine-grained, clay soils that are seasonally waterlogged or actually shallowly inundated, whereas *R. eburnea* is known only from seasonally moist, sandy soils.

*Conservation status:* Vulnerable (B1 + 2c, D).

#### Adjustments to distribution records of two Namaqualand species

*Romulea maculata* Manning & Goldblatt in *Adansonia* 23: 81 (2001).

This species was based on a single collection made on the summit of the Flaminkberg just southeast of Nuwerus in southern Namaqualand. The recent discovery of a second collection antedating the type by almost twenty years, substantially increases the known range of the species. This collection matches the type in all respects, including the large white flowers, bracts with broad, brown-spotted membranous margins and the white-spotted cataphyll and there is no doubt that it represents this species. *Romulea maculata* is now known from near Nuwerus in the south of Namaqualand to Komaggas in the north and may be expected to occur through most of the higher ground of Namaqualand. The species is restricted to seasonally moist, sandy loam on granitic slopes.

#### Additional material examined

NORTHERN CAPE.—2917 (Springbok): Farm Drierivier, (–DC), 17-08-1980, Van der Westhuizen 109/80 (NBG).

*Romulea multisulcata* M.P.de Vos in *Journal of South African Botany*, Suppl. 9: 139 (1972).

This species was described from seasonal pools on the Bokkeveld Mountains near Nieuwoudtville in Northern Cape (De Vos 1972) but later collections from the foot of the Gifberg-Matsikamma massif nearby (Manning & Goldblatt 2001), clearly represent a second set of populations differing from the type only in their white rather than yellow flowers. However, populations from Hondeklip Bay in central Namaqualand that were also assigned to this species on the basis of a single herbarium collection (Manning & Goldblatt 2001) prove, on examination of living plants, to lack the characteristic multisulcate leaves of *R. multisulcata* and accord more closely with *R. tabularis* Eckl. ex Bég. This species of waterlogged coastal flats is widely distributed along the west coast of South Africa from Cape Agulhas in the south to northern Namaqualand. The Hondeklip Bay populations thus fall within its recorded range. *Romulea multisulcata* thus remains endemic to southern Namaqualand, where it is restricted to a few scattered seasonal pools near Vanrhynsdorp and Nieuwoudtville.

#### Range extensions for *Romulea tabularis*

NORTHERN CAPE.—3017 (Hondeklipbaai): Koingnaas, Skulpfontein, (–AB), 24-08-1999, *Desmet* 222 (NBG); Farm Strandfontein, 15 km S of Wallekraal, (–DA), 25-08-1996, *De Villiers s.n.* (NBG177635); Groen River mouth, slopes above estuary  $\pm$  1 km from ocean, (–DC), 25-8-2002, *Goldblatt & Porter* 12116 (MO, NBG).

#### ACKNOWLEDGEMENTS

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# Studies in the genus *Riccia* (Marchantiales) from southern Africa. 26. A new species in section *Pilifer*, *Riccia radiata*, is described

S.M. PEROLD\*

**Keywords:** dorsal epithelium, *Riccia radiata* Perold, section *Pilifer* O.H.Volk, sporangia, spores, thallus

## ABSTRACT

*Riccia radiata* Perold, a new species endemic to southern Africa, is described. It is referred to section *Pilifer* O.H.Volk, which is characterized by the dorsal epithelium of the thalli consisting of short or long, free-standing, hyaline cell pillars.

## INTRODUCTION

Including this new species, 18 southern African species of *Riccia* have been referred to section *Pilifer*. The previous 17 species were treated in Perold (1999). As I remarked previously in Perold (1990a), the species assigned to this section, with rare exceptions, have  $\pm$  rounded, colourless scales and in several the spores have radiating ridges on the distal face. The dorsal cell pillars are composed of two or more hyaline cells: two cells in *R. pulveracea* (Perold 1990b) for example, and up to six cells joined end to end in *R. villosa* (Volk & Perold 1984). Once the thalli have dried out, the cells in the pillars collapse and it is often not possible to reconstitute them, especially if the plants have died. Fortunately, upon keeping some of the thalli of this new species damp in a closed transparent container for two weeks (16 months after collection), the distal parts of the thalli had revived sufficiently and could be studied. The ornamentation on both spore faces proved to be quite distinctive and it was quickly distinguished as a new species, which is described below.

### *Riccia radiata* Perold, sp. nov.

Thalli gregarii caespitiosi, apicem versus laete viridi, superficies dorsalis columnis cellularum munita mox collabentibus, caespites lanosos formantibus. Squamae hyalinae, arcte imbricatae. Sporae unice ornatae: superficies distalis cum cristis pluribus densis e centro radiatis (itaque nomen), areolis completis vel incompletis inter cristas; superficies proximalis granulis tenuis, interdum coalescentibus, confertim tecta.

**TYPE.**—Northern Cape, 3219 (Wuppertal): Cederberg, foothills of Bloukop along Luiperdskloof 4x4 route, altitude 1 290 m, on mountain slope, on sandy soil, (–CB), 2002-09-13, *M. Koekemoer* 2426 (PRE, holo.). Figure 1.

Thalli perennial, in gregarious patches, sometimes overlapping, not forming rosettes, dorsal face apically bright green and glistening, but soon becoming dotted with scattered white tufts of collapsed cell pillars, proxi-

mally shaggy, entirely covered with closely crowded, coarse white woolly tufts (Figure 3A–C); medium-sized, 6–11 mm long, growing from a narrow base,  $\pm$  0.5 mm wide and widening distally to 2.5 mm before bifurcation, in cross section slightly concave above and rounded below, 0.9 mm thick, i.e. nearly 3 times wider than thick (Figure 2C). *Branches* once or twice symmetrically or asymmetrically furcate, lobes ligulate, narrowly to moderately divergent, terminal segments 1.3–5.0 mm long, up to 2 mm wide, apex ovoid, rounded or wedge-shaped, once or twice shortly grooved (Figure 3B, C, E, F), margins acute, sides steep, with overlapping hyaline scales (Figure 2A). In cross section apically (Figure 2B), thallus branches dorsally V-shaped, only 0.6 mm thick from bottom of groove to ventral face, at erect sides up to 1.2 mm thick and here almost as thick as wide; ventrally rounded, green, hyaline scales barely visible, covered with rhizoids, 5.0–17.5  $\mu$ m wide, mostly smooth, rarely tuberculate. When dry, thallus generally white dorsally, sometimes tinged with pale green toward apex, slightly concave, margins erect or partially inflexed, sides white to pale yellow, covered with appressed scales, occasionally with narrow or broad, deep purple band along length of side, tailing off proximally. *Scales* along sides of thallus (Figure 3C, D), extending 200–250  $\mu$ m above dorsal face, closely imbricate,  $\pm$  oblong, somewhat forward projecting at leading edge (Figure 2F), rounded above, often sloping at following edge, margins entire, hyaline,

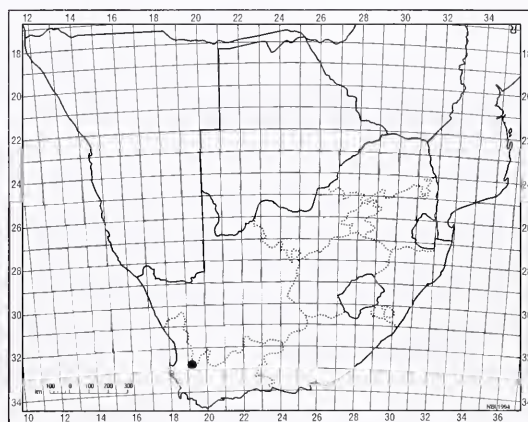


FIGURE 1.—Locality of *Riccia radiata* in southern Africa.

\* National Botanical Institute, Private Bag X101, 0001 Pretoria.  
MS. received: 2004-02-26.

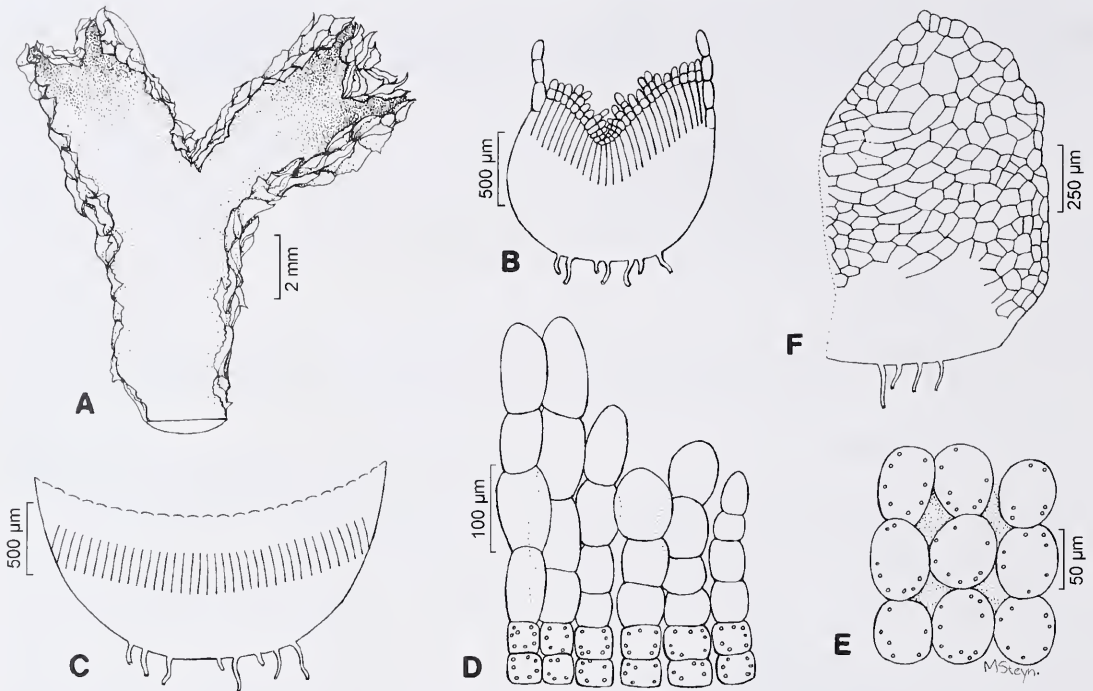


FIGURE 2.—*Riccia radiata*, M. Koekemoer 2426. A, proximal part of thallus and distal branches after bifurcation; B, c/s branch through apical groove; C, c/s proximal part of thallus before bifurcation, tops of collapsed dorsal pillars indicated by broken line; D, c/s dorsal cell pillars and top cells of assimilation tissue cell columns; E, horizontal section through basal cells of cell pillars with air pores dotted; F, scale. Scale bars: A, 2 mm; B, C, 500 µm; D, 100 µm; E, 50 µm; F, 250 µm. Drawn by M. Steyn.

800–950 µm high, 1130–1175 µm across widest part, cells in body of scale mostly elongated, 5- or 6-sided,  $92.5\text{--}137.5 \times 50.0\text{--}67.5$  µm, decreasing in size toward upper margin, where small and brick-shaped, in 1 or 2 rows; rhizoids arising from following edge.

*Dorsal epithelium* (Figure 2D) consisting of free-standing 3- or 4-celled hyaline pillars, fragile, 135–250 µm long, top cells ± spherical, conical or elongated with rounded apex, very variable in size,  $50\text{--}150 \times 30\text{--}75$  µm, next cell  $50.0\text{--}92.5 \times 45.0\text{--}62.5$  µm, basal cell (if 3 cells

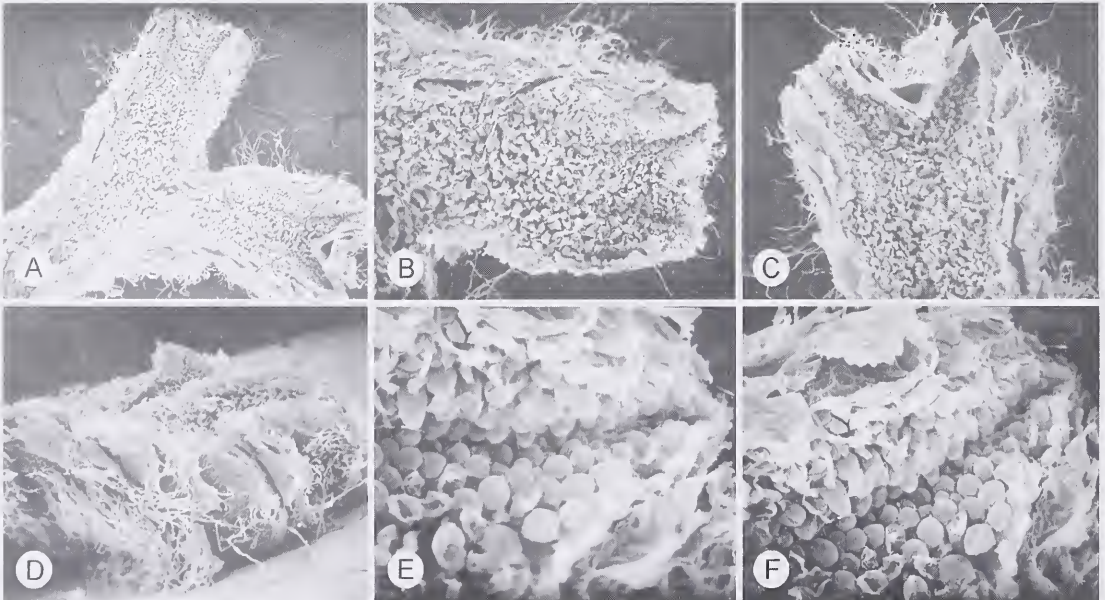


FIGURE 3.—SEM micrographs of *Riccia radiata*, M. Koekemoer 2426. A, distal branches of thallus after bifurcation; B, apical part of left branch (in A) with clumps of collapsed dorsal cell pillars; C, apical part of right branch (in A) and scales along sides; D, side view of branch, showing scales; E, F, groove at branch apex, with intact top cells of dorsal pillars on either side. A,  $\times 8.7$ , B–D,  $\times 16.5$ , E,  $\times 60.2$ ; F,  $\times 53.8$ .



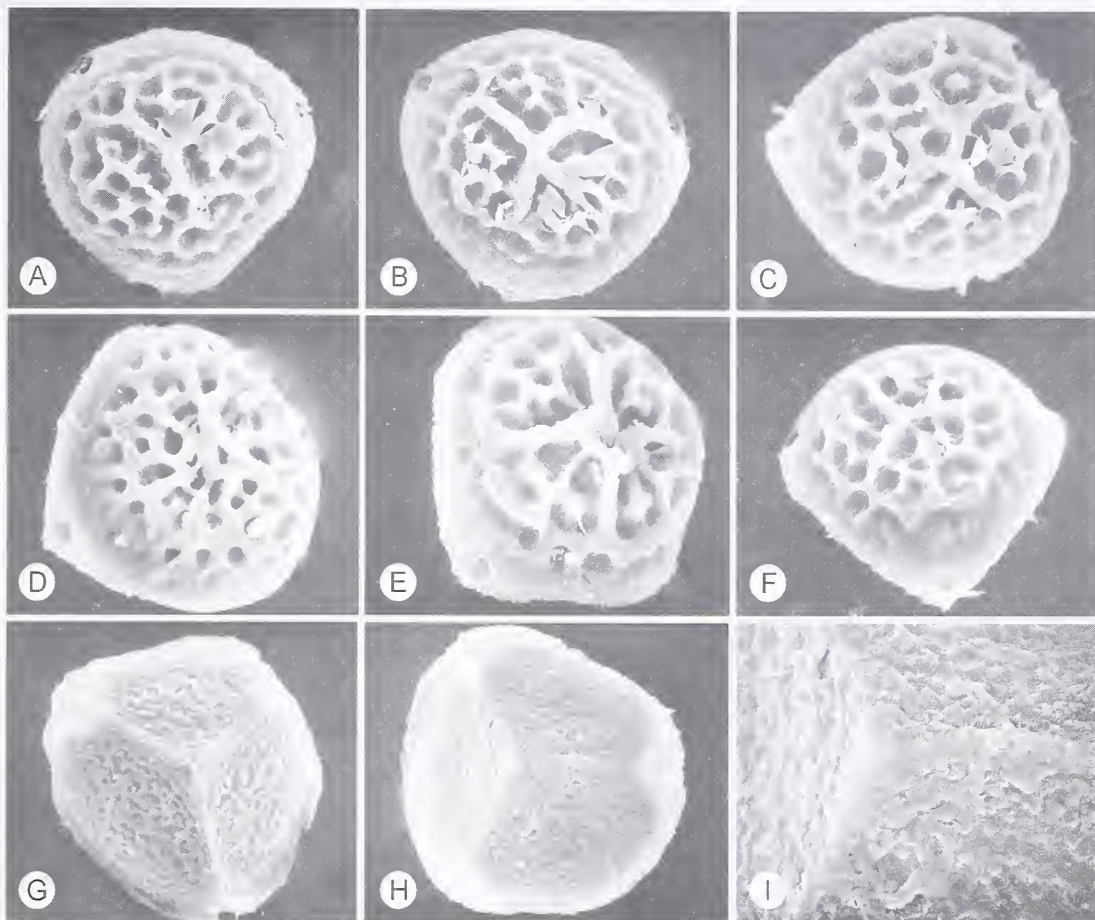


FIGURE 4.—*Riccia radiata*, M. Koekemoer 2426. Spores. A–F, distal face; F, side view. G, H, proximal face; I, apex of triradiate mark. A, H,  $\times 435$ ; B, F, G,  $\times 440$ ; C,  $\times 468$ ; D,  $\times 460$ ; E,  $\times 525$ ; I,  $\times 920$ .

in pillar)  $37.5\text{--}72.5 \times 35.0\text{--}57.5 \mu\text{m}$ , (if 4 cells in pillar)  $37.5\text{--}50.0 \times 30.0\text{--}32.5 \mu\text{m}$ ; air pores small (Figure 2E), often 4-sided,  $\pm 20 \times 20 \mu\text{m}$ , obscured by cell pillars. *Assimilation tissue*  $250 \times 300 \mu\text{m}$  thick in section,  $\pm \frac{1}{3}$  the thickness of thallus and consisting of vertical columns of  $\pm 8$  cells,  $35\text{--}50 \times 35\text{--}40 \mu\text{m}$ , enclosing narrow, 4-sided air canals; storage tissue  $350\text{--}400 \mu\text{m}$  thick, up to  $\pm \frac{1}{2}$  the thickness of thallus, cells crowded together, rounded to slightly angular,  $\pm 45 \times 50 \mu\text{m}$ ; rhizoids arising from ventral epidermal cells.

Monoicous? *Antheridia* not seen; hyaline necks probably obscured by woolly tufts of collapsed dorsal cells of thallus. *Archegonia* with dark red-brown necks, persistent and prominently projecting from bulging sporangia. *Sporangia* not very common, mostly single,  $800\text{--}875 \mu\text{m}$  wide, rarely up to 3 in close proximity near bifurcation of thallus. *Spores*  $92.5\text{--}110.0 \mu\text{m}$  diam., triangular-globular, polar, fairly dark brown, semitranslucent; wing sprinkled with granules,  $\pm 6 \mu\text{m}$  wide, gradually widening to  $15 \mu\text{m}$  at notched or perforated marginal angles, margin often minutely crenulate; ornamentation on distal face quite variable (Figure 4A–F), usually with 3–6 heavy ridges, up to  $5 \mu\text{m}$  wide, radiating from centre, in between ridges complete or incomplete

areolae,  $7.5\text{--}15.0 \times 7.5\text{--}12.5 \mu\text{m}$ , also thick-walled, sometimes with a central boss; proximal face (Figure 4G–I) with clearly defined triradiate ridge extending to margin, all 3 facets densely covered with fine granules, some coalescing.

This species has only been collected once. It was found growing on sandy soil on a mountain slope in the Northern Cape, at the border with Western Cape. This is a winter rainfall area with vegetation types Northwestern Mountain Renosterveld and Mountain Fynbos (Low & Rebelo 1996). The type locality is in a rather inaccessible place, along a newly opened 4x4 route. It is recognized as a new species mainly by the unique spore ornamentation which is characterized by exceptionally heavy ridges, and is referred to section *Pilifer* because of the free-standing cell pillars dorsally on the thalli. The specific epithet was chosen because of the radiating ridges on the distal face of many of the spores, quite different from those previously studied.

#### ACKNOWLEDGEMENTS

I sincerely thank the referees for their kind advice, also Dr M. Koekemoer for collecting the type specimen



of this new species. Dr H.F. Glen is thanked for suggesting the specific epithet and for translating the diagnosis into Latin. I also extend my gratitude to Mrs M. Steyn for the drawings and to Ms D. Maree for typing the manuscript.

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## Notes on African plants

VARIOUS AUTHORS

### SCROPHULARIACEAE

TYPE SPECIMENS OF *SELAGO*, *JAMESBRITTENIA* AND *SUTERA* AT NATAL UNIVERSITY HERBARIUM (NU)

The recent revisions of the Manuleae and Selagineae (Hilliard 1994, 1999) provide excellent accounts of these tribes. Unfortunately there are considerable omissions regarding type material housed at Natal University Herbarium (NU). For a number of the taxa, Natal University Herbarium holds the sole isotype and most of the holotypes are housed overseas in Edinburgh (E) or Missouri (MO).

#### SELAGINEAE

***Selago dolosa* Hilliard.** Type: Eastern Cape, 3225 (Somerset East): Boschberg, (–DA), 30-11-1977, *Hilliard & Burt* 10785 (E, holo.; NU).

***Selago florifera* Hilliard.** Type: Cape [Northern Cape], 3120 (Williston): between Calvinia and Middelpos on Bloemfontein road, (–CC), 30-09-1976, *Goldblatt* 4266 (MO, holo.; E, NU, PRE).

***Selago griquana* Hilliard.** Type: Natal [KwaZulu-Natal], 3029 (Kokstad): Swartberg, Matatiele on D492, just past Umzimkulu River, (–AC), 8-01-1986, *Hilliard & Burt* 18918 (E, holo.; K, NU, S).

***Selago hyssopifolia* E.Mey. subsp. *retrotricha* Hilliard.** Type: Natal [KwaZulu-Natal], 3029 (Kokstad): near Weza, Zuurburg, (–DA), 26-02-1975, *Hilliard & Burt* 8061 (E, holo.; K, NU, S).

***Selago inconstans* Hilliard.** Type: Eastern Cape, 3128 (Umtata): hill above Mhlahlane Forest Station, NW of Umtata,  $\pm$  5000 ft, (–BC), 31-01-1983, *Hilliard & Burt* 16343 (E, holo.; K, KEI, NU, PRE, S).

***Selago retropilosa* Hilliard.** Type: Eastern Cape, 3124 (Hanover): S extreme of Renosterberg above Lootsberg railway halt, Farm Blaauwater, 6000 ft, (–DD), 25-

11-1977, *Hilliard & Burt* 10651 (E, holo.; MO, NU, PRE, S).

***Selago tarachodes* Hilliard.** Type: Natal [KwaZulu-Natal], 2832 (Mtubatuba): St Lucia Estuary, (–AD), 15-08-1975, *Pooley* 1749 (E, holo.; K, NU).

***Selago variicalyx* Hilliard.** Type: Eastern Cape, 3326 (Grahamstown): Grahamstown Nature Reserve, Dassie Krantz,  $\pm$  2500 ft, (–AD), 2-12-1977, *Hilliard & Burt* 10798 (E, holo.; K, NU, S).

***Selago zuluensis* Hilliard.** Type: Natal [KwaZulu-Natal], 2831 (Nkandla): Ngoye Forest, (–DC), 15-01-1986, *Hilliard & Burt* 19052 (E, holo.; K, NU).

#### MANULEAE

***Jamesbrittenia multisecta* Hilliard.** Type: Eastern Cape, 3128 (Umtata): Umtata-Engcobo road near Umtata, (–DA), 21-11-1977, *Hilliard & Burt* 10552 (E, holo.; NU).

***Sutera glandulifera* Hilliard.** Type: Eastern Cape, 3226 (Fort Beaufort): Katberg Pass,  $\pm$  5800 ft, (–DA), 26-01-1979, *Hilliard & Burt* 12390 (E, holo.; K, M, NU, S).

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MS. received: 2003-02-28.

### PTERIDOPHYTA

*DRYOPTERIS FILIPALEATA* (PTEROPSIDA: DRYOPTERIDACEAE), A NEW SPECIES FROM TROPICAL EAST AFRICA

#### INTRODUCTION

In preparing a taxonomic review of the fern genus *Dryopteris* in Africa as well as for the *Flora of tropical East Africa*, several undescribed species have been identified. Earlier collectors generally ascribed their *Dryopteris* collections to either *D. inaequalis* (Schltdl.) Kuntze or to *D. pentheri* (Krasser) C.Chr., but a critical review of these species by me showed that they need to be more narrowly defined.

*Dryopteris filipaleata* J.P.Roux forms part of a group of species belonging to section *Marginatae* Fraser-Jenk. (Fraser-Jenkins 1986), to which both *D. inaequalis* and *D. pentheri* belong. The near similar stoma size in *D. filipaleata* [(40.0–)50.1(–62.0)  $\mu$ m] and *D. pentheri* [(34.0–)53.34(–72.0)  $\mu$ m], as well as spore size in *D. filipaleata* [(32.0–)41.1(–54.0)  $\times$  (18.0–)26.26(–34.0)  $\mu$ m] and *D. pentheri* [(38.0–)45.08(–60.0)  $\times$  (27.0–)31.32(–40.0)  $\mu$ m], suggest that *D. filipaleata* is tetraploid.

Furthermore, the development of 64 normal spores per sporangium indicates that the species is sexual. *Dryopteris filipaleata* can, however, be separated from *D. pentheri* by being exindusiate, eglandular and without 2-celled hairs. In *D. pentheri*, oblong glands (60.0–137.02(–260.0)  $\mu\text{m}$  long and 2-celled hairs generally occur along the lamina axes and veins. The narrow lamina scales also separate it from *D. pentheri*.

*Dryopteris filipaleata* appears to be restricted to Kenya and Tanzania—the Kenyan and Tanzanian mountain forests forming part of the Afromontane Region (White 1983). Lovett (1988) divided the Tanzanian forests into a number of subdivisions based on geographical, edaphic and floristic factors. These include the coastal forests, the Lake Victoria Basin forests, the Western mountain forests, also termed the Eastern Arc mountain forests, and the volcanic mountain forests. The Eastern Arc mountain forests, which have strong floristic similarities, show a high percentage of endemism (Brenan 1978; Lovett 1988). Floristically these forests differ from those on the adjacent recent volcanic moun-

tains and the basin forests (Lovett 1988). This may be ascribed to edaphic factors such as the different soil types.

***Dryopteris filipaleata* J.P.Roux, sp. nov.**, laminae paleis angustis denticulatis, paleis rhizomae stipitisque majoribus marginibus irregulariter laceratis et gemmis absentibus differt. Figura 1 & 2.

**TYPE.**—Tanzania, Eastern Province, Morogoro Dist. (T6), Uluguru Mountains, Mwere Valley, wet evergreen forest along stream with abundant *Cyathea manniana* and epiphytes, 1 400–1 450 m, 26 Sept. 1970, R.B. Faden, T. Pocs, B.J. Harris, & P. & K. Csontos 70/596 [BOL!, holo. (2 sheets); K!, iso. (2 sheets)].

Plants terrestrial. *Rhizome* short-decumbent, up to 12 mm diam., closely set with roots, persistent stipe bases and scales; scales linear acuminate to narrowly lanceolate, up to 15 mm long, up to 5 mm wide, ferrugineous to castaneous, chartaceous, broadly attached, irregularly

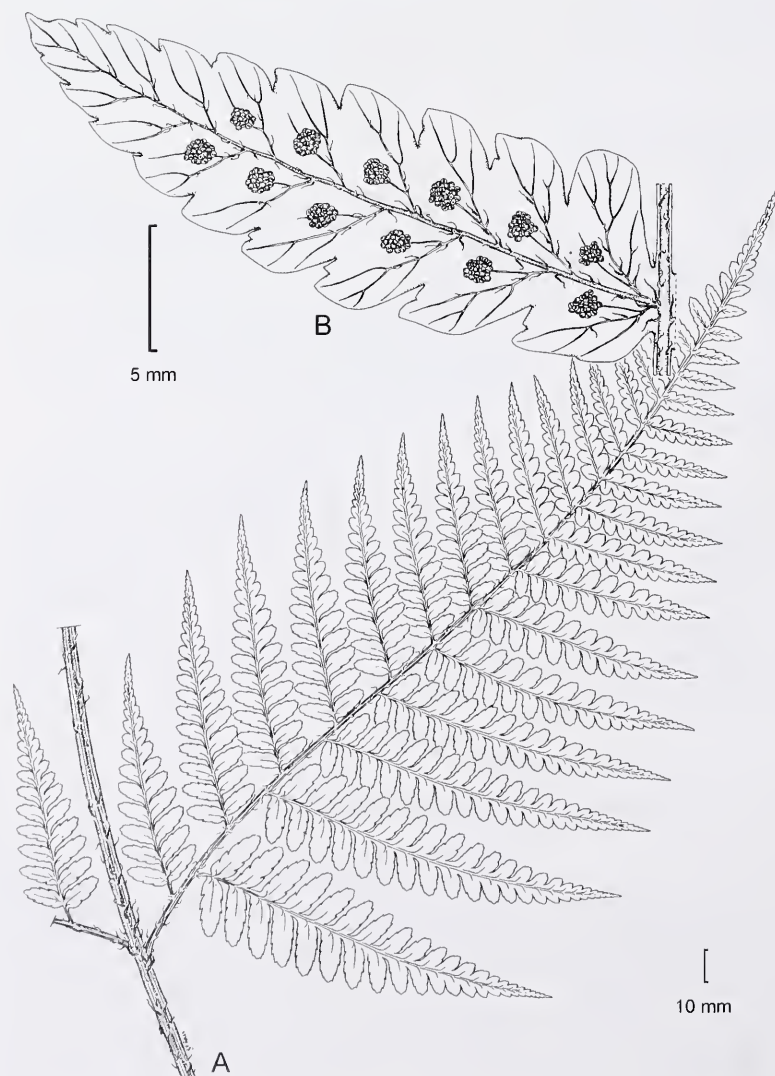


FIGURE 1—*Dryopteris filipaleata* J.P.Roux. A, basal pinna; B, abaxial view of pinnule. Drawn from R.B. Faden et al. 70/596 (K) by J.P. Roux. Scale bars: A, 10 mm; B, 5 mm.



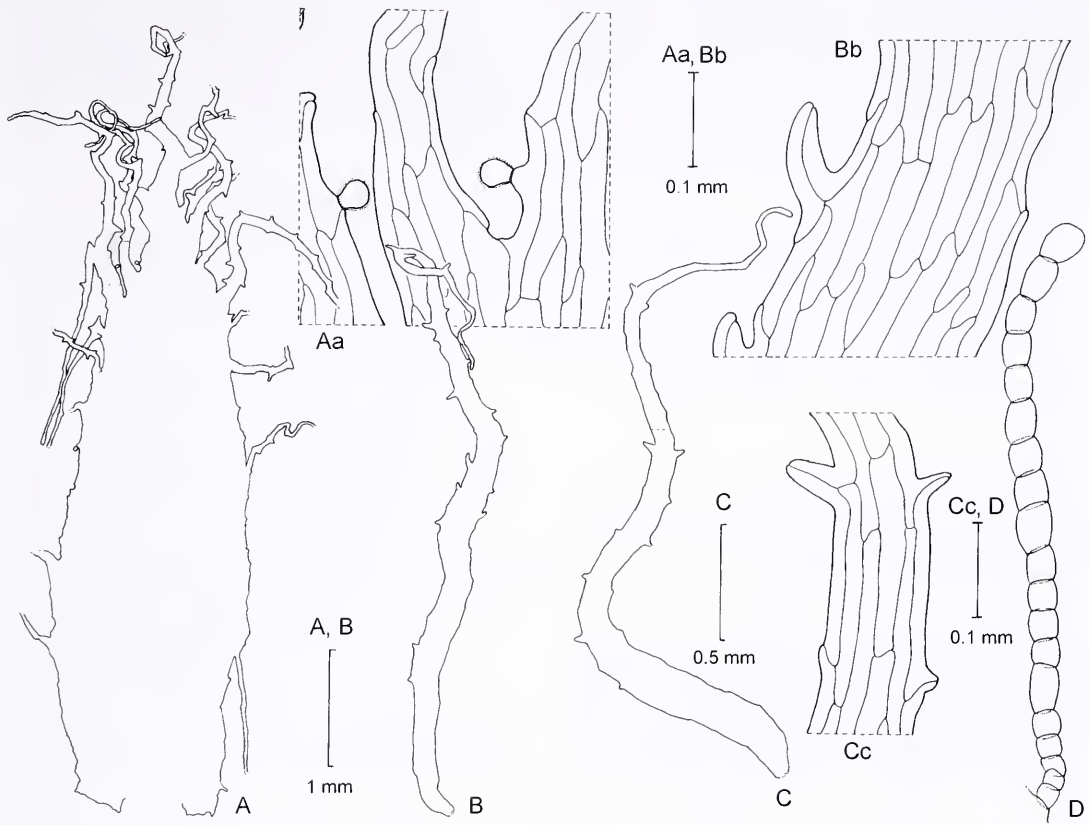


FIGURE 2—*Dryopteris filipaleata* J.P. Roux: vestiture. A, stipe scale; Aa, section showing cellular structure; B, rachis scale; Bb, section showing cellular structure; C, lamina scale, abaxial surface; Cc, section showing cellular structure; D, moniliform hair from abaxial surface of costa. Drawn from R.B. Faden et al. 70/596 (K) by J.P. Roux. Scale bars: A, B, 1 mm; C, 0.5 mm; Aa–Cc, D, 0.1 mm.

denticulate, irregularly set with scattered capitate glands, and long, pluricellular, denticulate outgrowths, in larger scales these outgrowths increase in number towards scale apex; apex irregularly denticulate, terminating in a short uniseriate series of cells. *Fronds* closely spaced, suberect to arching, up to 130 mm long; *stipe* up to 610 mm long, up to 7 mm diam., proximally castaneous and adaxially flattened, stramineous higher up and shallowly sulcate, proximally densely scaled, sparsely scaled higher up; scales up to 18 mm long, up to 6 mm wide, ferrugineous, chartaceous, similar to those on the rhizome. *Lamina* 2-pinnate-pinnatifid to 3-pinnate, ovate to broadly ovate in outline, up to 590 mm long, up to 430 mm wide, with up to 13 petiolated pinna pairs; rachis stramineous, sulcate adaxially, initially closely scaled, sparsely scaled later; scales linear-acuminate to filiform, up to 4 mm long, up to 0.5 mm wide, ferrugineous to castaneous, firmly herbaceous to thinly crustaceous, short-stalked, cuneate to narrowly cuneate, irregularly denticulate, apex terminating in a short series of oblong cells. *Pinnae* 1-pinnate-pinnatifid to 2-pinnate, near opposite to alternate, proximally more widely spaced, overlapping or not, basal pinnae petiolate, petiole up to 13 mm long, increasingly more broadly attached and basiscopically decurrent along rachis towards lamina apex, basal pinnae longest, up to 270 mm long, up to 135 mm wide, basal pair mostly conspicuously basiscopically developed, inaequilaterally triangular, those higher up mostly near symmetrical,

ovate, oblong-acuminate to lanceolate, with up to 7 stalked pinna pairs; pinna-rachis sulcate adaxially, narrowly winged towards apex, moderately scaled; scales linear to filiform, up to 3 mm long, up to 0.3 mm wide, ferrugineous to castaneous, firmly herbaceous to thinly crustaceous, short-stalked, irregularly denticulate, apex terminates in a short series of oblong cells. *Pinnules* firmly herbaceous, pinnatifid to 1-pinnate, near opposite to alternate, spaced to slightly overlapping, basal pinnules petiolate; petiolule up to 3 mm long, increasingly more broadly attached and basiscopically decurrent along pinna-rachis towards pinna apex; pinnules narrowly lanceolate to oblong-acuminate, up to 78 mm long, up to 26 mm wide, proximal basiscopical pinnules slightly basiscopically developed; costa sulcate adaxially, pronounced abaxially, flexuose towards apex, narrowly winged, sparsely scaled; scales filiform, up to 2.2 mm long, up to 0.1 mm wide, irregularly denticulate, apex terminates in a short series of oblong cells; segments and lobes ovate-obtuse to oblong-obtuse, up to 15 mm long, up to 7 mm wide, basiscopically decurrent, shallowly lobed to denticulate, adaxially glabrous or with few hairs and filiform scales along costa, abaxially sparsely set with scattered, (4–)6(–18)-celled moniliform hairs up to (78.0–)218.87(–615.0)  $\mu\text{m}$  long, on and between the veins. *Venation* evident, pinnately branched, mostly ending in teeth near margin. *Stomata* mostly of the polycytic type, (40.0–)50.1(–62.0)  $\mu\text{m}$  long. *Sori* predominantly 2-

seriate along pinnules, 2-seriate on lobes in larger plants, medial to inframedial on predominantly anadromous vein branches, exindusiate. *Sporangium*: stalk simple, glandular or haired; capsule with (13–)14(–19) indurated annulus cells, epistomium 4(–6)-celled, hypostomium (3–)6(–7)-celled; *spores* monolete, ellipsoid, with low reticulate ridges and bulges, up to (32.0–) 41.1(–54.0)  $\times$  (18.0–) 26.26(–34.0)  $\mu\text{m}$ . Figures 1, 2.

*Distribution and ecology*: *Dryopteris filipaleata* appears to be restricted to the mountainous areas of tropical East Africa occurring at altitudes ranging between 1 350 and 2 000 m. It grows in moist to wet evergreen forests either on the forest floor or along streambanks with *Cyathea manniana*, *Piper capense*, *Ensete ventricosa*, *Symphonia* spp., *Melchiora schliebenii* and *Allanblackia ulugurensis*.

#### Material examined

KENYA.—South Nyeri Dist. (K4), Kirinyaga Dist., Thiba Fishing Camp, 31 July 1977, *M.G. Gilbert & D. Rankin* 4821 (K); Meru Dist., Jombeni Range, 1 520 m, *H.D. van Someren* 438 (K, 2 sheets); Meru, upper forest, Aug. 1949, *H.D. van Someren* 493 (K); Kisumu-Londoni Dist. (K5), Kisumu, bushland, 2 128 m, Febr. 1915, *R.A. Dümmer* 1524 & 1727 (K).

TANZANIA.—Morogoro Dist. (T6), Uluguru Mountains, Morning-side to Bondwa, 1 350–1 900 m, 3–4 July 1970, *R.B. Evans et al.* 70/351 (K, 2 sheets); Uluguru Mountains, Mwere Valley, 1 400–1 450 m, 26 Sept. 1970, *R.B. Faden et al.* 70/596 (BOL, 2 sheets, K, 2 sheets); Uluguru Forest Reserve, Lupanga Peak, 2 000 m, 1981, *J.B. Hall s.n.* (K); Kanga Mountain, Northern Nguru, 1 800 m, 2 Dec. 1987, *J. Lovett & D.W. Thomas* 2800, 2802 & 2802A (MO); Bagamoyo Dist., mainland west of Zanzibar, March 1885, *J.T. Last s.n.* (K).

#### ACKNOWLEDGEMENTS

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#### LAMIACEAE

##### PLECTRANTHUS MZIMVUBUENSIS, A NEW SPECIES FROM EASTERN CAPE, SOUTH AFRICA

**Plectranthus mzimvubuensis** Van Jaarsv., sp. nov., a *P. reflexo* verticillis brevibus 70–90 mm longis, tubo corollae usque ad 10 mm longo, lateribus parallelis, et staminibus tubum corollae aequantibus vel superantibus, differt.

TYPE.—Eastern Cape, 3129 (Port St Johns): near Ludonga Village, Mzimvubu River, Ecca Group shale cliffs, (–AD), *Van Jaarsveld, Xaba, Harrower & Zwide* 92 (PRE, holo.).

Perennial, branched, aromatic shrub up to 1 m tall, 3 m diam., scandent and pendent from cliffs. *Roots* fibrous to slightly fleshy, but bearing distinct oblong to rounded tubers; tubers 25–50  $\times$  14–20 mm, grey, tissue translucent and slightly yellowish. *Stems* herbaceous, semisucculent, 4-angled, terete in older branches and with a succulent basal caudex, 100 mm diam. *Bark* smooth, grey. *Leaves* thin-textured and drying chartaceous, broadly ovate-deltoid to subrotund, (15–)25–50(–75)  $\times$  (20–)28–50(–60) mm, apex acuminate, with a short drip-tip, base truncate to subcordate, occasionally slightly decurrent on petiole, adaxial surface sparsely strigose becoming glabrescent, abaxial surface prominent reticulate-veined, strigose, becoming less so with age, covered with slightly sunken, translucent gland dots (sessile glandular trichomes) becoming yellowish brown in dried specimens, veins

densely strigose and with similar gland dots; margin serrate-dentate with 6–10 pairs of teeth (0.5–)1–2(–4) mm long, ciliate; petiole reddish purple, 10–20(–30) mm long, finely strigose with unbranched, multicellular translucent hairs, sparsely beset with gland-tipped trichomes. *Inflorescence* short, terminal, verticillate, (30–)70–90(–120) mm long, sometimes with a pair of side branches at base; rachis sparsely strigose, bearing scattered, sessile, yellowish brown gland dots and unbranched, multicellular, glandular trichomes; bracts broadly ovate, acuminate, 7  $\times$  4 mm. *Flowers* in sessile, 1–3-flowered cymes forming 2–6-flowered verticillasters, the latter 6–12(–18) mm apart; pedicels 5–8 mm long, finely strigose, bearing few, multicellular, gland-tipped trichomes. *Calyx* up to 4 mm long, accrescent, lengthening to 10–11 mm in fruit, densely covered with sessile, yellowish brown gland dots at base, 2-lipped; upper lip erect, broadly ovate, abruptly acuminate,  $\pm$  3 mm long; lower lip 4-toothed, teeth acuminate; tube  $\pm$  8 mm long. *Corolla* pink; tube straight, 9–10 mm long, laterally compressed, 3 mm wide, slightly deflexed forming a swollen saccate base, sparsely beset with translucent hairs, 0.2–3.0 mm long, 2-lipped; upper lip 4-lobed, 8 mm high, becoming reflexed when stigma matures; upper lobes bent forward and forming an ascending, spreading 2-spurred hood, ventral margin of upper lobes overlapping two upper margins of lateral lobes and each lobe forming a characteristic spur up to 2

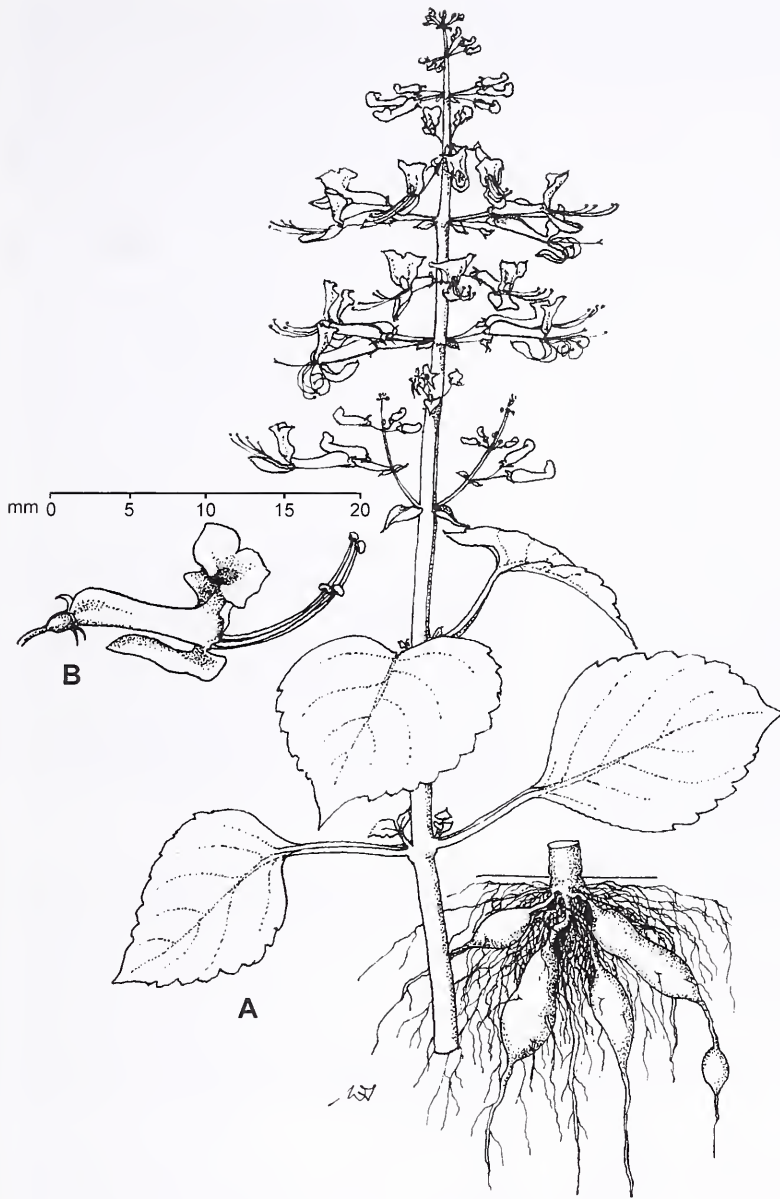


FIGURE 3.—Type specimen of *Plectranthus mzimvubuensis*: A, habit,  $\times 0.8$ ; B, flower. Artist: Vicki Thomas.

mm deep, apex of spur beset with translucent hairs, 0.5–1.0 mm long; lower lip boat-shaped, 6 mm long, soon becoming reflexed. *Stamens* 4, free, fused to tube  $\pm 1.5$ –2.0 mm from throat, didynamous, lower pair exposed for 14–15 mm, upper pair exposed for 10–11 mm, both pairs becoming reflexed; anthers versatile; pollen cream-coloured. *Style* 14 mm long extending up to 20 mm when mature, exposed for  $\pm 8$  mm. *Nutlets* rounded,  $1.5 \times 1.3$  mm, dark brown, smooth. *Flowering time*: autumn (March and April). Figure 3.

*Plectranthus mzimvubuensis* is at once distinguished from *P. reflexus* Van Jaarsv. & T.J. Edwards by its shorter parallel-sided corolla tube which is 10 mm long, whereas that of *P. reflexus* is longer, 25 mm, and constricted at the mouth. *P. mzimvubuensis* is a much-branched scram-

bler from a rootstock bearing distinct root tubers, whereas *P. reflexus* is an erect shrub with fleshy roots. In both species the lips and stamens become reflexed and the mature style is twice the length of the corolla tube. According to Codd's (1985) key in his treatment for the *Flora of southern Africa* (28,4: 141), the new species would key out to '28' which includes five species, *P. ambiguus*, *P. ecklonii*, *P. dolomiticus*, *P. petiolaris* and *P. laxiflorus*. Of these, the corolla of *P. petiolaris*, *P. laxiflorus* and *P. dolomiticus* are curved like a 'Dutchman's pipe'. *P. mzimvubuensis* can be distinguished from *P. ecklonii* and *P. ambiguus* by its short corolla of 9–10 mm with the lobes of the upper lips hooded, their lower margins overlapping the lateral lobes and forming two short spurs, each 2 mm long and ending in a translucent hair, 0.5–2.0 mm long. The spurred upper lobes of the corolla



are a unique feature in the genus *Plectranthus*, possibly assisting flying insects in effective pollination. The corolla tube of *P. ecklonii* is 12–18 mm long and slightly expanding to the throat, whereas the corolla tube of *P. ambiguus* is 20–25 mm long.

*Plectranthus mzimvubuensis* is a scrambling shrub with pendent branches. It is endemic to south-facing Ecca Group shale cliff faces (Karoo Supergroup) along the Mzimvubu River, upstream from Port St Johns in Eastern Cape (Figure 4). *P. mzimvubuensis* was first collected during a rubber-boat expedition to study the cremophilous flora of the Mzimvubu River Valley in the autumn of 2002. The Mzimvubu River, after which this species is named, is the largest river in the Transkei portion of Eastern Cape. The Xhosa name *Mzimvubu* means 'the home of the hippopotamus' (*Hippopotamus amphibius*), but these animals were wiped out in the area more than a century ago. The new species was encountered below Ludonga Village, about 40 km from the river mouth, at an altitude of  $\pm 600$  m. The vegetation consists of savanna and the rainfall occurs mainly from spring to autumn, 800–1 000 mm per annum. The climate is subtropical, with hot summers, dry, sunny, frost-free winters and cool evenings. The population of *P. mzimvubuensis* was encountered on a south-facing cliff in light shade, together with other succulent plants such as *Adromischus cristatus*, *Bulbine natalensis*, *Crassula cordata*, *C. cultrata*, *C. multicava* subsp. *floribunda*, *C. orbicularis*, *Cyanotis speciosus*, *Delosperma tradescantioides* and *Peperomia blanda*. Trees and shrubs in the area include *Bauhinia bowkeri*, *Celtis africana*, *Ficus burkei* and *Euphorbia tirucalli*. Cuttings taken from *P. mzimvubuensis* rooted rapidly and are grown at Kirstenbosch National Botanical Garden.

Although only a small population of the new species was found, no threats seem to exist on or near the cliff face and the species is expected to be more common in similar habitats elsewhere in the river valley. Its present conservation status is classified as Rare, but not threatened.

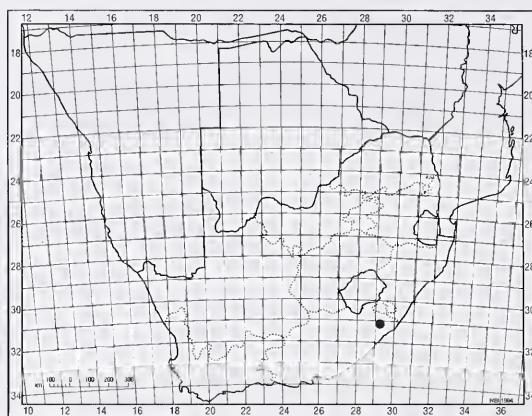


FIGURE 4.—Known distribution of *Plectranthus mzimvubuensis*.

#### ACKNOWLEDGEMENTS

We thank Gerrit Germishuizen and Emsie du Plessis for editing the text and Dr Hugh Glen for translating the diagnosis into Latin. The Eastern Cape Department of Tourism & Nature Conservation in Umtata is thanked for providing plant-collecting permits. The authors also thank colleagues Phakamani Xaba and Adam Harrower for their help on the expedition and Godfrey Zwide of the Eastern Cape Department of Tourism & Nature Conservation in Umtata for accompanying the authors and providing assistance on this expedition.

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## PTERIDOPHYTA

### *DRYOPTERIS GORGONEA* (PTEROPSIDA: DRYOPTERIDACEAE), A NEW SPECIES FROM THE CAPE VERDE ISLANDS

#### INTRODUCTION

The Cape Verde is a group of 10 major islands and several smaller islands situated in the Atlantic Ocean (15–17°N, 23–25°W),  $\pm 620$  km west of the coast of Mauritania. Nine of the islands, which are of volcanic origin, are inhabited. The Barvalento or Windward Islands consist of Santo Antão, São Vicente, Santa Luzia, Ilheu Branco, Ilheu Raso, São Nicolau, Sal and Boa Vista, whereas the Sotavento or Leeward group consists of Maio, Santiago, Fogo and Brava. Santiago, the main island, is mountainous and like most islands it is arid. Fogo has the highest peak within the island group with Mt Fogo reach-

ing 2 840 m. Santo Antão, the most northern island has the highest rainfall. The climate is oceanic with daily highs ranging between 20–29°C from August to October.

The island group has a depauperate flora as a result of its arid climate. To date, 35 pteridophyte species have been recorded for the Cape Verde Islands (Lobin *et al.* 1998). *Dryopteris* collections from the islands have been ascribed to various taxa, of which a summary is provided by Lobin *et al.* (1998). Fraser-Jenkins (1982) was the first to show that two *Dryopteris* species occur on the islands, ascribing them to *D. oligodonta* (Desv.) Pic.Serm. and *D. pentheri* (Krasser) C.Chr.

During the review of the African *Dryopteris* species currently undertaken by me, I had the opportunity to study most of the relevant types. I therefore can confirm that *D. oligodonta* is indeed one of the species occurring in the Cape Verde Islands. The other species, however, ascribed to *D. pentheri* by Fraser-Jenkins (1982), and embraced by Lobin *et al.* (1998) is not that species, but represents a distinct entity. Furthermore, several collections belonging to this taxon have erroneously been ascribed to *D. oligodonta* by Lobin *et al.* (1998).

The earliest available name for this taxon appears to be *Dryopteris elongata* (Aiton) Sim var. *simplex* A.Chev. However, in describing the variety, three collections were cited of which *Chevalier 45476* is taken as the type, as he states 'Covão, 900 m alt. avec le type 45476,' whereas the other two collections are considered as paratypes (Chevalier 1935). In spite of Chevalier clearly having designated his number 45476 as the holotype, it was lectotypified by Lobin *et al.* (1998) with the same collection. This collection, however, is *D. oligodonta* whereas *Chevalier 45113* and *45499* are not. *Dryopteris elongata* var. *simplex* therefore becomes a synonym of *D. oligodonta*. Since no name exists for *Chevalier 45113* and *Chevalier 45499*, it is here described as *D. gorgonea*, an epithet derived from the Gorgades, an old geographical name for the island group.

***Dryopteris gorgonea* J.P.Roux, sp. nov., a *D. oligodonta* stomatibus bene majoribus glandibus laminae differt.**

TYPE.—Cape Verde Islands, Fogo, Espia, Mosteiros, 1-08-1934, A. Chevalier 45113 (P!, holo.; COI!, K!, iso.).

Plants terrestrial. *Rhizome* up to 50 mm long, up to 5 mm in diameter, suberect to erect, closely set with roots, crowded stipe bases and scales. *Fronds* up to 1 020 mm long, suberect to arching; *stipe* up to 640 mm long, up to 9 mm in diameter, proximally castaneous, adaxially flattened and densely set with glands and pluricellular dendroid hairs and scales; larger stipe scales up to 23 mm long, up to 3 mm wide, concolorous or bicolorous, if bicolorous then centrally castaneous to ferrugineous with a narrow stameneous margin, firmly herbaceous, broadly attached, linear-attenuate, margin variously set with long, reflexed, pluricellular, mostly uniseriate hairs and capitate glands; capitate glands also occur on the scale surface; apex flagelliform; *stipe* higher up stramineous, shallowly sulcate and sparsely scaled, larger scales up to 5 mm long, up to 4 mm wide, fugaceous, concolorous, ferrugineous to stramineous, chartaceous, broadly attached, lanceolate to broadly ovate, variously set with few short or long marginal outgrowths and glands, surface variously set with capitate glands, apex flagelliform. *Lamina* herbaceous, ovate to broadly ovate, up to 650 mm long, up to 31 mm wide, anadromous, catadromous towards apex, up to 2-pinnate-pinnatifid, with up to 13 petiolated pinna pairs; rachis adaxially shallowly sulcate, narrowly winged towards apex, variously set with clavate glands and scales; scales up to 5 mm long, up to 4 mm wide, fugaceous, stramineous to ferrugineous, chartaceous, broadly attached, margins variously set with a few short and/or long outgrowths and glands, surface variously set with capitate glands; apex flagelliform. *Pinnae* near opposite to alternate, slightly overlapping or

not, up to 1-pinnate-pinnatifid, basal pair mostly longest, not conspicuously basiscopically developed, ovate, lanceolate, or oblong-acute distally, up to 193 mm long, up to 85 mm wide, with up to 6 petiolated pinnule pairs; petiole up to 8 mm long; pinna-rachis shallowly sulcate adaxially, narrowly winged for most of the length, closely set with clavate glands, sparsely scaled; scales lanceolate to broadly ovate, up to 3.5 mm long, up to 1 mm wide, ferrugineous to stramineous, chartaceous, sessile, often somewhat bullate, variously set with short or long, mostly uniseriate hairs and capitate glands, few capitate glands also occur on scale surface, apex terminates in a short or long uniseriate series of oblong cells. *Pinnules* near opposite to alternate, slightly overlapping or not, pinnatifid, ovate to oblong-obtuse, up to 48 mm long, up to 24 mm wide, adaxially glandular along and between veins, also with scattered isocytic hairs along costa, abaxially closely set with clavate glands (50–)68.48(–98)  $\mu$ m long and isocytic hairs along veins; hairs often glandular near base; costa adaxially shallowly sulcate, glandular, abaxially variously scaled; scales up to 3 mm long, up to 1 mm wide, ferrugineous to stramineous, chartaceous, sessile to short-stalked, often somewhat bullate, similar to those on pinna-rachis; petiolule up to 2 mm long; segments oblong-obtuse, up to 13 mm long, up to 6 mm wide, lobed; lobes dentate, teeth cuneate. *Venation* anadromous, catadromous towards apex, pinnately branched, branches end in teeth near margin. *Stomata* mostly of polocytic type, (42–)53.31(–64)  $\mu$ m long. *Sori* circular, medial on predominantly anadromous vein branches, 2-seriate on segments, discrete or touching at maturity, up to 1.2 mm diam.; *indusium* brown, firmly herbaceous, up to 0.5 mm diam., flabellate, entire to repand, glandular along margin and on surface. *Sporangium*: stalk simple, glandular, or haired; capsule with (10–)13(–16) indurated annulus cells, epistomium 4(or 5)-celled, hypostomium 4(or 5)-celled; *spores* brown, ellipsoidal, monolet, perispore folded to form narrow reticulate ridges, (38–)42.44(–46)  $\times$  (24–)27.86(–32)  $\mu$ m. Figure 5A–I.

#### *Diagnostic features and relationships*

*Dryopteris gorgonea* differs from *D. pentheri*, to which it was formerly ascribed, in the scales often bearing capitate glands on the surface and the presence of clavate glands (50–)68.48(–98)  $\mu$ m long along the frond axes and on the lamina surfaces. In *D. pentheri* the glands are oblong, (60–)137.02(–260)  $\mu$ m long, and restricted to the frond axes and veins. Also the 2-celled hairs diagnostic of *D. pentheri*, have not been recorded for *D. gorgonea*. *Dryopteris gorgonea* is closely related to *D. oligodonta*, but differs in the longer clavate glands [(36–)51.31(–60) vs. (50–)68.48(–98)  $\mu$ m] and larger stomata [(30–)37.54(–48) vs. (42–)53.31(–64)  $\mu$ m]. The larger stomata suggest it being tetraploid, rather than diploid, as is *D. oligodonta* (Fraser-Jenkins 1982).

#### *Distribution and ecology*

*Dryopteris gorgonea* appears to be endemic to the Cape Verde Islands having been recorded from Santo Antão, São Vicente and the summit of Monte Gordo on São Nicolau. Unfortunately, no ecological information has been record-

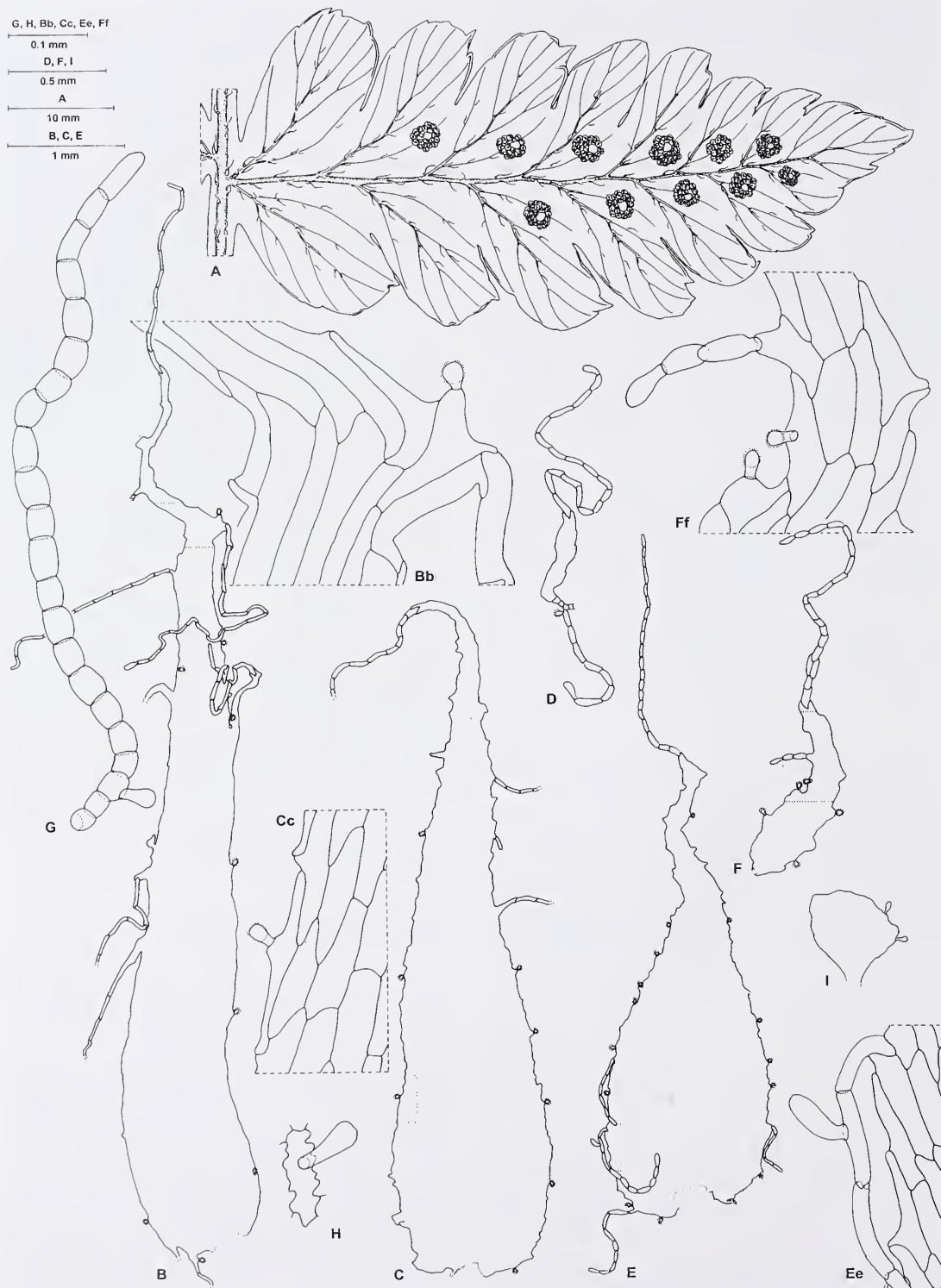


FIGURE 5.—A–I: *Dryopteris gorgonea*. A, abaxial view of fertile pinnule; B, stipe scale; Bb, section of B showing cellular structure; C, D, rachis scales; Ce, section of C showing cellular structure; E, secondary rachis scale; Ec, section of E showing cellular structure; F, scale from abaxial surface of costa; Ff, section of F showing cellular structure; G, hair from abaxial surface of lamina; H, clavate gland from abaxial surface of lamina; I, indusium. Scale bars: A, 10 mm; B, C, E, 1 mm; D, F, I, 0.5 mm; Bb, Cc, Ee, Ff, G, H, 0.1 mm. Drawn from *Chevalier 45113 (P)* by J.P. Roux.



ed. No recent collections of the species appear to have been made from any of the islands and it has been suggested to be extinct (Lobin & Ormonde 1996; Lobin *et al.* 1998). Since the species closely resembles *D. oligodonta*, a careful search for it on the islands should continue.

#### Other material examined

CAPE VERDE ISLANDS.—São Nicolau: in summo monte Gurdo, 1851, *C. Bolle s.n.* (COL, K); Monte Gordo, 24-02-1864, *R.T. Lowe s.n.* (K); *Forbes s.n.* (K). Santo Antão: Covão, 09-1934, *A. Chevalier 45499* (P); Covão, 23, 24-09-1934, *A. Chevalier 45532* (COL, K, P). Sine loc.: Cape Verdes, *Cardosa 169* (K); Cap du Vert, *Forbes s.n.* (K).

#### ACKNOWLEDGEMENTS

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### CRASSULACEAE

#### *ADROMISCHUS SCHULDtianus* SUBSP. *BRANDBERGENSIS*, A NEW SUBSPECIES AND A CHECKLIST OF THE SUCCULENT FLORA OF THE BRANDBERG, NAMIBIA

#### INTRODUCTION

*Adromischus schuldianus* (Poelln.) Poelln. subsp. *brandbergensis* B.Nord. & Van Jaarsv., a new subspecies endemic to the Brandberg, northwestern Namibia, is described. Since its discovery by H.J. Wiss below Aigub Peak (Nordenstam 1974), by the second author on Königstein and Orabeskop, and later by P.V. Bruyns (Craven & Craven 2000), this taxon, due to its distinct leaf characters and isolated distribution, demanded some form of taxonomic recognition. The new subspecies is at once distinguished from *A. schuldianus* (Poelln.) Poelln. subsp. *schuldianus* by its subfusiform-ellipsoid and semiterete leaves without a clear margin; they are usually shallowly concave above, becoming channelled during the dry season. Both *A. schuldianus* subsp. *schuldianus* and subsp. *juttiae* have dorsiventrally flattened, oblanceolate (rarely obovate) leaves.

***Adromischus schuldianus* (Poelln.) Poelln.** subsp. ***brandbergensis*** B.Nord. & Van Jaarsv. subsp. nov., differt a *A. schuldiano* (Poelln.) Poelln. subsp. *schuldianus* foliis subfusiformibus-ellipsoideis plusminusve semiteretibus 20–90 mm longis 10–15 mm crassis supra applanatis vel leviter concavis sine margine distincto apice acutis-obtusis saepe recurvatis.

**TYPE.**—Namibia, 2114 (Uis): Orabeskop, 2 300 m, Brandberg Mountain, (–AA), 06-04-1964, *Nordenstam 3677* (ex hort. Bot. Garden, Lund, specimen in WIND, holo.!: M!, S!, iso.).

Dwarf mat-forming, branched succulent up to 70 mm high, filling crevices in granite rock fissures. *Roots* fibrous. *Branches* short and succulent, in cultivation up to 70 × 10 mm. *Leaves* alternate, spreading, subfusiform-ellipsoid to ± semiterete, 20–70 × 10–15 mm, without a

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distinct margin, flattened to shallowly concave above, tapering to base and acute-obtuse and often somewhat recurved at tip, dark green and marbled with white or dull red areas. *Inflorescence* a ± one-sided raceme with 2–15 almost patent flowers; peduncle 150–500 mm long (in cultivation), 1.2–1.5 mm thick, simple or branching above middle, terete, glabrous, greenish brown or reddish; bracts 1.5 mm long, acute, succulent; bracteoles 2, basal, subulate, ± 1 mm long, acute; pedicels 5–17 mm long, somewhat thickened towards apex. *Calyx*: lobes narrowly triangular, 1.8–2.0 × 0.6–1.0 mm, acute. *Corolla* 12–15 mm long, pinkish white or wax-coloured; tube cylindrical, 2.5–3.0 mm wide; lobes patent, deltoid, acute, with somewhat wavy margins; throat bright purple inside. *Styles* subulate-filiform, 5–8 mm long, white at apex, pale green at base. *Squamae* oblong, bifid, 1 × 0.8 mm, white. *Stamens*: filaments white or pinkish, five longer ones adnate for 5 mm, ± 12 mm long, five shorter ones adnate for 3 mm, ± 10 mm long; anthers oblong, 0.4 mm long. Figure 6.

*Adromischus schuldianus* subsp. *brandbergensis* appears to be endemic to the Brandberg Mountain in northwestern Namibia (Figure 7). It occurs in rock crevices of steep southern and eastern slopes and cliffs of the mountain from ± 1 500 m to ± 2 300 m. It is not common anywhere but occurs scattered in protected fissures and crevices in small to dense groups due to vegetative proliferation. Associated plants in the same habitat include *Aloe dichotoma*, *A. hereroensis*, *A. littoralis*, *Cyphostemma currorii* and *Kalanchoe lanceolata*, also *Diospyros acocksii*, *Euphorbia mauritanica*, *Ficus ilicina*, *Obetia carruthersiana*, *Salvia garipensis* and *Tetradenia riparia*.

In his 1985 revision of the genus *Adromischus*, Toelken recognized 27 taxa. A very handy popular version of the same account was published by Pilbeam *et al.* in 1998,

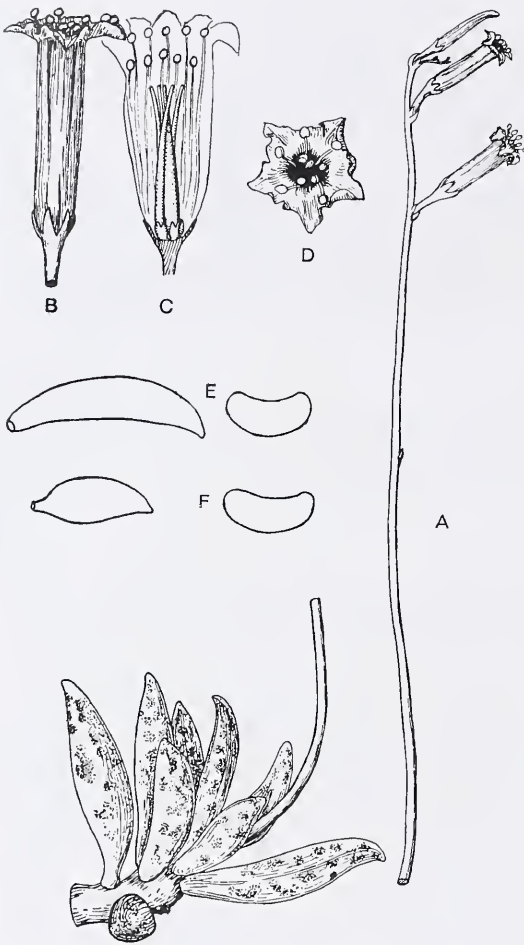


FIGURE 6.—*A. schuldianus* subsp. *brandbergensis* B.Nord. & Van Jaarsv. Illustration based on a cultivated plant that flowered in the Botanical Garden, Lund, Sweden: A, flowering branch,  $\times 1$ ; B, flower,  $\times 2.5$ ; C, corolla, opened to show styles and stamens,  $\times 2.5$ ; D, corolla, dorsal view,  $\times 2.5$ ; E, F, leaf outlines in side view and transect,  $\times 1$ . Reprinted, with permission, from Nordenstam. Drawn by Bertil Nordenstam.

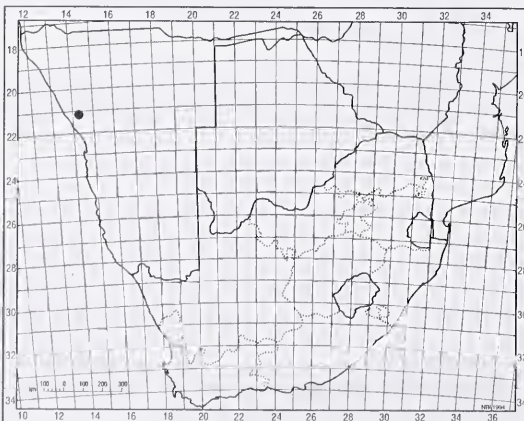


FIGURE 7.—Known distribution of *Adromischus schuldianus* subsp. *brandbergensis*.

reflecting the horticultural value of the group. *Adromischus schuldianus* subsp. *brandbergensis* belongs to section *Boreali* (Toelken 1978) which includes a few other taxa confined to the northern parts of South Africa and Namibia, for example, *A. schuldianus* subsp. *schuldianus*, *A. trigynus* and *A. umbraticola*. From these the new subspecies is at once distinguished by its subfusiform or almost terete leaves distinctly concave on the upper side. It is found the furthest north of any *Adromischus* species.

Of all the members of section *Boreali*, *A. trigynus* has the most southern distribution. It is confined to dolerite outcrops, growing in shallow soil at altitudes above 1 000 m in the Nama-Karoo Biome in an area that receives predominantly summer and autumn rain. *A. trigynus* ranges from southern Namibia and Pofadder in the west to Aliwal North and the southern Free State in the east.

*Adromischus umbraticola* occurs on south-facing cliffs and in the shallow soil of sandstone and quartzite outcrops on the Highveld of Gauteng, mountains of the North-West and further north to the Blouberg and Chuniespoort (Limpopo). It is common on rocky ridges of the Witwatersrand and in the Magaliesberg range. The vegetation of its habitat consists mainly of dry, short savanna. It has very brittle leaves, and plants often colonize shallow pockets of soil where there is little competition from mesophytic taxa.

Toelken (1985) recognizes two subspecies of *A. schuldianus*, namely subsp. *schuldianus* and subsp. *juttae*, characterized by their oblanceolate to obovate leaves but mainly differentiated by their stem and branch length, 40–80 mm tall, and little branched in subsp. *juttae* as opposed to branches 10–30 mm long in subsp. *schuldianus*, which occurs in arid savanna in central Namibia, from the Erongo and Auas Mountains in the north to near Aus Village and the Karas Mountains in the south. It grows on rock outcrops, usually with a southern aspect. The second subspecies, *A. schuldianus* subsp. *juttae* is confined to the Karasberg in southern Namibia and is differentiated by its longer branches; the plants occur in the Nama-Karoo. Bruyns (1990) noticed variability in the leaf shape of *A. schuldianus* subsp. *schuldianus* on the Brandberg. He found flat- and fusiform-leaved plants occurring together. However, in spite of some local variation, the majority of specimens encountered on the Brandberg are represented by the subterete-leaved plants here described as a distinct subspecies.

The Brandberg is an isolated granite inselberg of  $\pm 21 \times 25$  km and Königstein (2 573 m) represents the highest peak in Namibia. It is surrounded by Namib Desert with typical species such as *Welwitschia mirabilis*, annual herbs and grasses, and foothills with woody species including *Acacia montis-usti*, *Adenolobus garipensis*, *Commiphora saxicola*, *C. virgata*, *C. wildii* and *Moringa ovalifolia*. The rainfall on the lower slopes is low (less than 100 mm per annum) and typical of the Namib.

A total of 480 species was recorded from the mountain by Craven & Craven (2000). The vegetation of the Brandberg is slowly transformed with altitude (increase in rainfall, decrease in temperature). At 2 000 m and above it is reminiscent of renosterveld, not unlike the

vegetation found in the winter rainfall Kamiesberg of Namaqualand, and many genera are shared between the two regions. The Brandberg itself has a number of endemics (Nordenstam 1974; Craven & Craven 2000): *Felicia gmillae*, *Hermannia merxmuelleri*, *Lithops gracilidelineata* subsp. *brandbergensis*, *Nidorella nordenstamii*, *Pentzia tomentosa*, *Plumbago wissii*, *Ruellia brandbergensis* and the recently described *Philyrophyllum brandbergense* (Herman 2003). Our new *Adromischus* subspecies brings the total of endemic taxa to nine. A number of other taxa are near-endemic to the Brandberg, being known from one or a few localities outside the Brandberg. The Brandberg is treated by Van Wyk & Smith (2001) as a local focus of endemism within a larger Kaokoveld Centre of plant endemism.

#### Other material examined

NAMIBIA.—2114 (Uis): Brandberg, Königstein, E slopes, 2 400 m, 31-05-1963. *Nordenstam* 2837 (cult. in Bot. Garden, Lund, specimen in S); *Bruyns* 3302 (BOL); *Van Jaarsveld* 17969 (NBG).

#### ACKNOWLEDGEMENTS

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- Our list was compiled from unpublished field notes kept by the authors, as well as from a critical assessment of the published species lists of Nordenstam (1974) and Craven & Craven (2000). Included in the list are 54 species belonging to 17 families, alphabetically arranged according to family, then according to genus and species. We have adopted the definition for succulence provided by Smith *et al.* (1997), namely that a succulent is a plant that stores water in its tissues as a mechanism to survive periods of drought in the growing phase.
- Aizoaceae**  
*Sesuvium sesuvioides* (Fenzl) Verde. var. *sesuvioides*  
*Tetragonia*  
*arbuscula* Fenzl  
*calycina* Fenzl
- Apocynaceae/Asclepiadaceae**  
*Hoodia gordonii* (Masson) Sweet ex Decne.  
*Orbea maculata* (N.E. Br.) L.C. Leach subsp. *rangeana* (Dinter & A. Berger) Bruyns  
*Sarcostemma viminale* (L.) R.Br. subsp. *viminale*  
*Stapelia*  
*kwebensis* N.E.Br.  
*longipedicellata* (A. Berger) L.C. Leach
- Asphodelaceae**  
*Aloe*  
*asperifolia* A. Berger (flats surrounding mountain)  
*dichotoma* Masson var. *dichotoma*  
*hereroensis* Engl. var. *hereroensis*  
*littoralis* Baker  
*viridiflora* Reynolds
- Asteraceae**  
*Othonna brandbergensis* B.Nord.  
*Kleinia longiflora* DC.
- Burseraceae**  
*Commiphora*  
*glaucescens* Engl.  
*krauseliana* Heine  
*pyracanthoides* Engl.  
*saxicola* Engl.  
*tenuipetiolata* Engl.  
*virgata* Engl.  
*wildii* Merxm.
- Crassulaceae**  
*Adromischus schultdtianus* (Poelln.) Poelln. subsp. *brandbergensis* B.Nord. & Van Jaarsv.  
*Cotyledon orbiculata* L. var. *orbiculata*  
*Crassula*  
*subaphylla* (Eckl. & Zeyh.) Harv. subsp. *subaphylla*  
*tabularis* Dinter  
*Kalanchoe lanceolata* (Forssk.) Pers.
- Cucurbitaceae**  
*Corallocarpus*  
*schinzii* Cogn.  
*welwitschii* (Naudin) Hook.f.
- Euphorbiaceae**  
*Euphorbia*  
*gariepina* Boiss. subsp. *balsamea* (Hiern) L.C. Leach  
*guerichiana* Pax  
*mauritanica* L. var. *mauritanica*  
*monteiroi* Hook.f. subsp. *brandbergensis* B.Nord.  
*virosa* Willd. subsp. *virosa*
- Lamiaceae**  
*Aeollanthus neglectus* (Dinter) Launert  
*Tetradenia riparia* (Hochst.) Codd
- Mesembryanthemaceae**  
*Aptenia geniculiflora* (L.) Bittrich ex Gerbaulet  
*Hereroa puttkameriana* (Dinter & A. Berger) Dinter & Schwantes  
*Lithops gracilidelineata* Dinter  
subsp. *brandbergensis* (de Boer) D.T. Cole  
subsp. *gracilidelineata*  
*Mesembryanthemum guerichianum* Pax
- Moringaceae**  
*Moringa ovalifolia* Dinter & A. Berger

#### LIST OF SUCCULENTS RECORDED FROM THE BRANDBERG

To date the most detailed published checklist for the flora of the Brandberg is that by Craven & Craven (2000). In the latter list the authors indicate the growth form for each species/infraspecific entry. Although 'succulent' is one of the growth forms provided for, this state was applied very inconsistently. For example, no *Aloe* is marked as a succulent, whereas this is the prevailing state in the genus. Hence we here provide an updated list of those species with a succulent growth form recorded from the Brandberg. It is hoped that this list will prove useful to workers interested in comparing the Brandberg flora with other areas where the proportion of succulent taxa may differ (e.g. the high Kamiesberg in the Succulent Karoo further south).



**Passifloraceae****Adenia***pechuelii* (Engl.) Harms*repanda* (Burch.) Engl.**Portulacaceae***Avonia albissima* (Marloth) G.D.Rowley**Portulaca***kermesina* N.E.Br.

\*oleracea L.

**Talinum** sp.**Sterculiaceae****Sterculia***africana* (Lour.) Fiori var. *africana**quinqueloba* (Garcke) K.Schum.**Vitaceae****Cyphostemma***bainesii* (Hook.f.) Desc.*congestum* (Baker) Desc. ex Willd & R.B.Drumm.*currorii* (Hook.f.) Desc.**Welwitschiaceae***Welwitschia mirabilis* Hook.f.**Zygophyllaceae***Zygophyllum simplex* L.E.J. VAN JAARSVELD\*†, B. NORDENSTAM\*\*  
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**ERICACEAE****NOMENCLATURAL CHANGES IN ERICA**

***Erica salicina*** E.G.H.Oliv., nom. nov., *E. viminalis* E.G.H.Oliv. in *Bothalia* 31: 5 (2001) non *E. viminalis* Salisb.: 298 (1796) [= *E. albens* L.]. Type: Western Cape, 3319 (Worcester): Hex River Mountains, Milner Peak, on wet shaded cliffs at base of amphitheatre, E side, 5000 ft [1 520 m], (–AD), 4 January 1959, *Esterhuysen* 28100 (BOL, holo.; BM, E, G, K, L, MO, NBG, NY, P, PRE, S, W).

Salisbury's name (1796) was overlooked when naming this very localized species with its distinctive, willow-like habit. The new name repeats the etymological reference to the habit, *salicinus* = like the genus *Salix* [*viminalis* = willow]. At the time of description only the type material was known. Recently the species was re-collected in the very impressive amphitheatre of the Hex River Mountains by Nicholas Helme who noted that there were only two adult plants that had escaped the fire of three years previously with few signs of any young plants. The habitat was a permanently wet drip zone which probably receives direct sunlight for only two weeks in the year.

***Erica pilaarkopensis*** H.A.Baker in *Journal of South African Botany* 41: 128 (1975). Type: 3419 (Caledon): Pillarkop [Pilaarkop], Riviersondereinde Mtns, (–BB), near Lindeshof on scree and steep rock slopes, alt. 1 220–1 524 m, *Esterhuysen* 33343 (BOL, holo.; NBG).

Baker (1975) gave the specific epithet *pilaarkopensis* to this species based on the locality of the type collection, which he cited as 'Pillarkop'. However the details given by Esterhuysen in her own hand on the holotype, refer to the location as 'Pilaarkop' which is the spelling

noted on all reference maps. The label details as copied by Baker onto the isotype in his own herbarium (now in NBG) give the locality as 'Pillarkop' and the specific epithet as *pilaarkopensis* [sic]. It could be suggested that Baker deliberately translated the Afrikaans *pilaar* to the English *pillar*. If this is the case then why did he retain the Afrikaans *kop* for peak. I contend that being an immigrant Englishman unfamiliar with the language, he mis-copied the name in his manuscript and on the label in error. I therefore correct the spelling of the specific epithet to reflect the accepted Afrikaans spelling of the name of the locality as permitted by Article 60.1 of the International Code (Greuter *et al.* 2000).

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ERICACEAE

A NEW SPECIES OF INDEHISCENT-FRUITED *ERICA* FROM THE CENTRAL KOUEBOKKEVELD,  
WESTERN CAPE, SOUTH AFRICA

INTRODUCTION

The genus *Erica* L. in southern Africa has recently been enlarged by the reduction to synonymy of the 18 small, indehiscent-fruited Cape genera, or ‘Minors’ (Oliver 2000). The inclusion of the 84 species resulted in a total of ± 765 species for the genus. Since then, one additional indehiscent-fruited species, *E. rusticula* E.G.H. Oliv., has been described and this paper adds another, *E. tragomontana*.

*Erica* possesses either a dehiscent, indehiscent or partially dehiscent fruit. Two dehiscence strategies are displayed within the partially dehiscent type: 1. partial, active dehiscence when the drying out of the valves causes an incomplete split along suture lines; and 2. partial, passive dehiscence when valves do not open independently and the swelling of the developing seed forces the valves to open partially (Oliver 2000: 49, 50). In both instances seeds are not released from the capsule. The new species described here has a wholly indehiscent fruit, no swelling or splitting of the ovary occurring during or after ripening. Roughly 680 dehiscent-fruited species occur throughout southern Africa, whereas the 86 indehiscent and partially dehiscent-fruited species are confined to the Cape Floral Kingdom between Nieuwoudtville in the northwestern Cape and Port Elizabeth in Eastern

Cape (Oliver 2000). Marked centres of species richness occur in the Kogelberg/Grabouw area, Riviersonderend Mountains and Central Kouebokkeveld, 16–18, 15 and 13 species occurring per quarter degree grid (± 14 × 17 km) respectively (Oliver 2000: 87–95). The discovery of *E. tragomontana* therefore raises the number of indehiscent-fruited species in the central Kouebokkeveld (grid reference: 3319AB) to 14.

*Erica tragomontana* R.C.Turner, sp. nov., in grege specierum olim in generibus minorum fructibus indehiscentibus positorum, *Ericae bokkeveldiae* E.G.H. Oliv. et *Ericae rusticulae* E.G.H.Oliv. & I.M.Oliv. affinis, sed ab eis pilis ovarii densis longis lanatis apicalibus, staminibus 5 vel 6 interdum 4 rare 7, sepalibus bracteae appressis ovato-lanceolatis, foliis latioribus longioribus, habitu sparsiore erecto differt. Figura 8.

TYPE.—Western Cape, 3319 (Worcester): central Kouebokkeveld, Bokberg southwest of Winkelhaak Farmstead, southeast-facing slopes below trig. beacon 4, 1 257 m, (–AB), 9 October 2002, Turner 530, (NBG, holo.; BM, K, NY, PRE).

Plants up to 350 mm tall, erect, single-stemmed reseeders. *Branches*: several erect, main and numerous short,

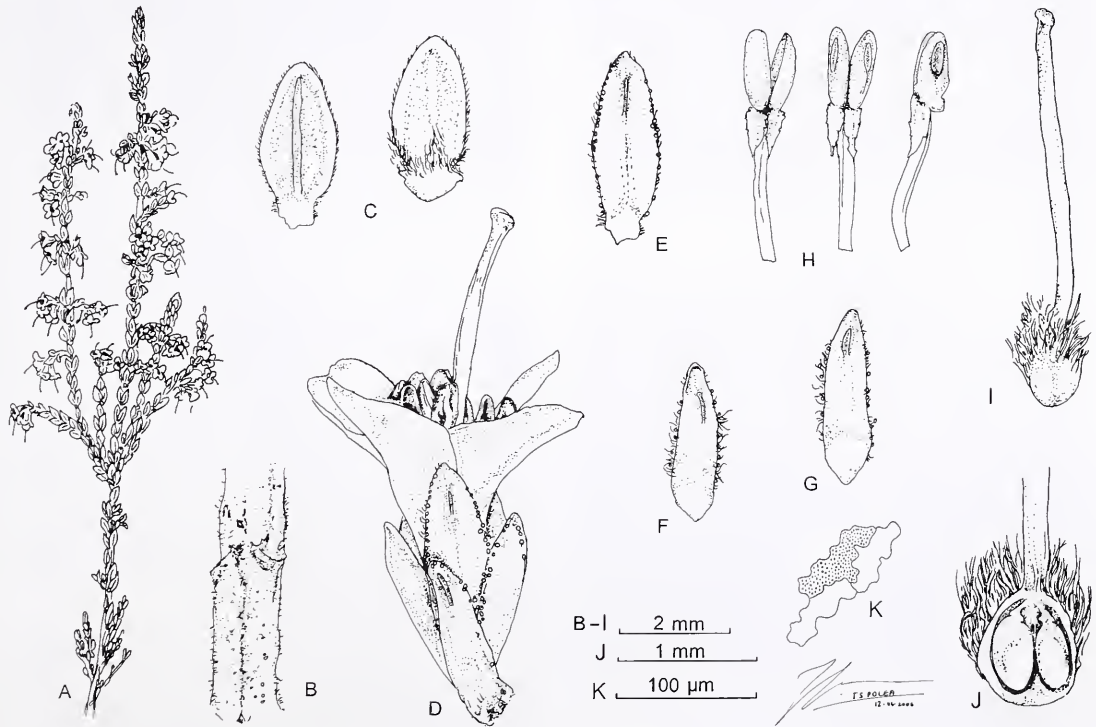


FIGURE 8.—*Erica tragomontana*. A, flowering branch, natural size; B, stem; C, leaf, abaxial view (left), adaxial view (right); D, flower; E, bract; F, bracteole; G, sepal, abaxial view; H, stamen, back, front and side views; I, gynoecium; J, 1/5 ovary; K, testa. All drawn from type, Turner 530. Artist: Traci Polea. Scale bars: B–I, 2 mm; J, 1 mm; K, 100 μm.

partially decurved secondary branches; stems, younger with short stiff hairs, older subglabrous with occasional short hairs; weak infrafoliar ridges. *Leaves* 3-nate, narrowly ovate,  $1.0\text{--}2.4 \times 1.2$  mm, narrowly sulcate, abaxially glabrous, hairy on basal portions adaxially, reddish green, margins hyaline and ciliate; petiole  $0.25\text{--}0.4$  mm long, yellow. *Inflorescence*: flowers 1 to 3-nate, terminal on short, secondary branchlets; pedicel  $0.1$  mm long, red, with short, sparse hairs; bract partially recaulescent, adpressed, leaf-like, ovate-lanceolate,  $1.4\text{--}1.6$  mm long, minutely sulcate, pinkish green, margins ciliate with sessile glands; bracteoles 2, approximate, adpressed, longer than bract, oblong to lanceolate,  $1.6\text{--}1.8$  mm long, subacute, keeled, minutely sulcate, pink, margins ciliate with sessile glands, abaxially and adaxially glabrous. *Calyx* 4-lobed; sepals adpressed, ovate-lanceolate, keeled, subacute,  $1.6$  mm long, glabrous, pink, margins ciliate with sessile glands. *Corolla* 4-lobed, broadly funnel-shaped,  $2.75\text{--}3.3$  mm long, glabrous, colliculate, pink, margins erose, lobes spreading broadly apically, narrow basally. *Stamens* (4) 5 or 6 (7), free, manifest; filaments linear with a slight sigmoid bend, broadening basally,  $1.6\text{--}1.8$  mm long, glabrous, pink; anthers dorsally fixed at base, bipartite, erect, scabrous, reddish brown; thecae  $0.72\text{--}1.0$  mm long; appendages pendulous, dorsally fixed at bases of thecae,  $0.6$  mm long, linear, reddish purple, erose, scabrous, pores  $0.2\text{--}0.36$  mm long; pollen in monads. *Ovary* 2-locular, ovoid,  $0.8\text{--}1.1$  mm long, laterally flattened, dense, long lanate hairs apically and halfway down lobes, otherwise glabrous, reddish purple, 1 ovule per locule, placenta apical, no basal nectaries; style truncate,  $2.6\text{--}3.8$  mm long, far exserted, glabrous, pink; stigma minutely capitate. *Fruit* indehiscent, ovoid,  $0.8\text{--}1.1$  mm long, verrucose, reddish brown with long lanate apical hairs, otherwise glabrous; pericarp smooth, subcolliculate, thin, brittle, brown; mesocarp thin, red; endocarp thin, papery, pale cream. *Seeds* ellipsoid,  $\pm 0.8$  mm long; testa yellowish brown, cells elongate with unevenly jigsawed anticlinal walls and numerous small to medium-sized pits. *Flowering time*: September to early November. Figure 8.

#### Diagnostic features and discussion

Superficially resembling *E. bokkeveldia* and *E. rusticula*, *E. tragomontana* differs in having mostly 5 or 6, sometimes 4 and rarely 7 stamens, with long, woolly, apical hairs and halfway down the lobes of the ovary; adpressed ovate-lanceolate sepals, bract and bracteoles; narrowly ovate leaves of  $1.0\text{--}2.4 \times 1.0\text{--}1.2$  mm; and a sparser, erect habit. *E. bokkeveldia* has pendulous, 3-nate, broadly funnel-shaped flowers with very short pedicels,  $0.1\text{--}0.5$  mm long, borne terminally on short, secondary branches; 3-nate leaves; aculeate anthers with broad, pendulous appendages; a 2-locular ovary with one pendulous ovule per locule and an apical placenta; but differs from *E. tragomontana* in having scarious, broadly ovate sepals; oblanceolate bract and bracteoles; eight stamens; and an apically and sparsely pubescent ovary. The general habit is also compact and more rounded, the species usually growing on drier, sandy, quartzitic flats in low proteoid/restioid fynbos at the bases of the surrounding mountains (R.C. Turner pers. obs.).

*Erica rusticula*, endemic to substrate derived from quartzitic Witpoort Formations in the northern Koue-

bokkeveld, also has pink, broadly funnel-shaped flowers with very short pedicels,  $0.3$  mm long, borne terminally on short, partially decurved secondary branches; filaments with an apical sigmoid bend, a far exserted, truncate style with a minutely widened stigma; 3-nate leaves; and a 2-locular indehiscent ovary with one pendulous ovule per locule. This species differs from *E. tragomontana* in having branches with short, dense, reflexed hairs; slightly shorter, imbricate leaves, with entirely hairy adaxial surfaces; flowers with only four stamens; filaments that broaden apically; non-scarious anthers with very short, narrow, pendulous appendages; shorter, straight, dense hairs covering the top  $\frac{3}{4}$  of the ovary surface and a subapical placenta; as well as a compact, woody and more rounded habit, especially in old plants (Oliver & Oliver 2000; R.C. Turner pers. obs.).

However, *E. tragomontana* also displays several similar morphological characters to the dehiscent-fruited *E. argentea* Klotzsch ex Benth., particularly the 3-nate leaves; the branches with weak infrafoliar ridges and fine hairs; the very short pedicel,  $0.16\text{--}0.29$  mm long, the 3-nate flowers borne terminally on short, partially decurved, secondary branchlets; the adpressed bract, bracteoles and sepals; the filaments with a slight sigmoid bend; the scabrous thecae with pendulous appendages; an apically hairy ovary; and an erect, slightly lax habit. This is not a unique instance, as character similarities between the indehiscent-fruited *E. cetrata* E.G.H. Oliv. and the dehiscent-capsuled *E. macrostema* Guthrie & Bolus var. *glabripedicellata* Dulfer have been noted (Oliver 2000: 287). A closer inspection of *E. tragomontana* reveals an indehiscent, laterally-flattened 2-locular ovary with 1 ovule per locule and a lack of nectaries; mostly 5 or 6, sometimes 4 and rarely 7 stamens; and a broadly funnel-shaped corolla with spreading lobes. *E. argentea* has a dehiscent, 4-locular ovary with occasionally 1, usually 2–5 and rarely 7–9 ovules per locule, as well as basal nectaries; 8 stamens; and a narrowly obconical to urceolate corolla.

Character adaptations related to the protection of the fruit differ between the three indehiscent species. In *E. tragomontana* the hardened, adpressed sepals continue to clasp the base of the corolla tightly when dried flowers fall to the ground, providing added protection for the slightly sclerified fruit for a further period of time (Turner 728; pers. obs.). The dried, hardened base of the corolla tube protects the fruit of *E. bokkeveldia* after flowering, whereas in *E. rusticula* a thicker pericarp and seed testa perform this function (Oliver & Oliver 2000). While *E. tragomontana* usually possesses a 2-locular ovary with one ovule per locule ( $G \frac{2}{1}$ ), an exceptional situation was observed during dissection of mature fruits (Turner 728; pers. obs.), in which one locule contained two developed seeds and the second contained a flattened, unfertilized ovule.

As *E. tragomontana* possesses an indehiscent fruit, pollen in monads and a  $G \frac{2}{1}$  ovary, it would appear to be allied with the major basal polychotomy of 62 taxa within the indehiscent-fruited species (Oliver 2000). Due to the lack of clear indications of infrageneric relationships within the now greatly enlarged genus *Erica*, indehiscent-fruited species have been temporarily retained at the



end of the genus (Oliver 2000 in Oliver & Oliver 2000) and this new species is therefore provisionally placed after *E. rusticula* as species number M45.2.

Pollination syndrome

The pollination syndrome of *E. tragomontana* is unresolved. Although the species has no floral nectaries, only a slight stigmatic enlargement (minutely capitellate) has occurred, a similar condition also existing with *E. rusticula* (Oliver 2000) and the question is thus posed as to what exactly the pollination strategies of these species are, neither being specifically adapted for entomophily nor anemophily.

Thrips, common visitors to many *Erica* species, have been observed under magnification in the anther pores of fresh material of *E. tragomontana* (Turner 530, 592; pers. obs.) but these insects are considered too small to be effective pollinators (Rebello *et al.* 1987). The anthers of *E. tragomontana* possess relatively large, broad and pendulous appendages, suggesting some form of entomophily, although no pollinators have been observed during field study. Even though the flowers of *E. tragomontana* have no nectaries and do not emit a noticeable scent (R.C. Turner pers. obs.), it is very possible that larger flying insects, such as bees, visit the plant for its pollen reward alone (Rebello *et al.* 1987).

Distribution and habitat

*Erica tragomontana* is known only from two subpopulations occurring in the central Kouebokkeveld on the Bokberg and Sandberg (Figure 9), hence the specific epithet *tragomontana*, referring to the type locality on the Bokberg: *tragus* (Latin) = goat = *bok* (Afrikaans). Remarkably, the relatively dry Bokberg complex consisting of the Bokberg, Houdenbeksberg, Sandberg and Vaalboskloofberg, supports at least 14 indehiscent and 38 dehiscent *Erica* species as well as three subspecies of taxa occurring within the complex (R.C. Turner pers. obs.).

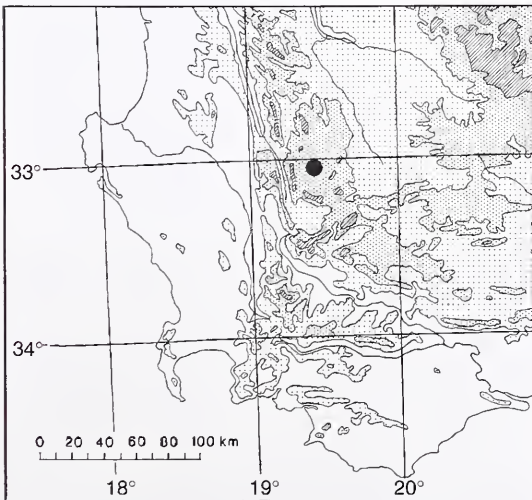


FIGURE 9.—Known distribution of *E. tragomontana*.

Upon initial discovery, only 15 plants were found in a small winter seepage area but it is now known that these plants represent the fringes of the Bokberg subpopulation as specimens have since been found to thrive in far greater numbers on drier, rocky, south- to southeast-facing slopes in a sandy substrate derived from resistant Witpoort formations of the Witteberg Group (Spatial Data Management Unit 1997). This quartzitic sandstone rock comprises both the Bokberg and Sandberg. At the type locality the species grows in association with *E. eremioides* (MacOwan) E.G.H.Oliv., *E. incarnata* Thunb., *E. melastoma* Andrews variant D (Oliver & Oliver 2002), *E. nudiflora* L., *E. recurvifolia* E.G.H.Oliv., *Aulax pallasia* Stapf (Proteaceae), *Sorocephalus lanatus* Thunb. (Proteaceae) and several species of Restionaceae. The Sandberg subpopulation occurs on a similar rocky, sandy, south-facing slope of identical substrate, growing in association with *E. arachnocalyx* E.G.H.Oliv., *E. argentea*, *E. monsoniana* L.f., *E. nudiflora*, *E. recurvifolia* and *E. virginalis* Klotzsch ex Benth., as well as several species of Restionaceae. Both populations occur between 1 140–1 280 m and may be snowbound for short periods of time during the winter months of May to September.

Paratype material

WESTERN CAPE.—3319 (Worcester): Bokberg, Kouebokkeveld, upper south-facing slopes S of beacon 4, 1 280 m. (–AB), 06-10-2001, Turner 381 (NBG); SE-facing slopes of Bokberg S of trig. beacon 4, fruiting material, 1 257 m. (–AB), 10-03-03, Turner 728 (NBG); rocky S-facing slopes S of Sandberg, spot height 1 341 m, Peerboomkloof, Kouebokkeveld, 1 240 m. (–AB), 09-11-2002, Turner 592 (NBG); Bokberg, Hartebeeskloof 216, southern slopes SE of beacon 4, 1 280 m. (–AB), 10-10-2002, Oliver 12069 (BM, BOL, E, K, MO, NBG, NY, P, PRE).

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SPATIAL DATA MANAGEMENT UNIT. 1997. 1:250 000 Geological Map, 3319 (Worcester).

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## FABACEAE

A NEW SPECIES OF *ACACIA* (MIMOSOIDEAE) FROM MPUMALANGA, SOUTH AFRICA

## INTRODUCTION

Botanically poorly explored areas of South Africa continue to yield exciting new plant discoveries and records (Hurter & Van Wyk 2001). During the course of fieldwork aimed at expanding the living plants collection of the Lowveld National Botanical Garden, Nelspruit, several potentially new species of *Acacia* have been collected for the first time, one of which is described in the present contribution. The new species is a yellow-flowered member of subgenus *Acacia* section *Acacia* subsection *Uniseriae* (Vassal 1974; Guinet & Vassal 1978; Chappill & Maslin 1995; Timberlake *et al.* 1999).

***Acacia ebutsiniorum* P.J.H.Hurter, sp. nov.**, a speciebus omnibus austro-africanis pedunculis longissimus (70–90 mm) robustis, foliolis cum margine hyalino differt. *A. antunesii* similis est sed habitu (suffrutex vel arbor parva ad 2.5 m alta, non arbor magna ad 6 m alta), foliis glabris, glandula petiolaris magna, crateriforme, leguminibus constrictis subfalcatis differt.

TYPE.—Mpumalanga, 2630 (Carolina); Ebutsini tribal land, Farm Tothiertoe 7 JT, 1 100 m, 8 November 2000, (–BB), P.J.H. Hurter 133 (PRE, holo.; K, NBG, PRU, iso.).

Small tree up to 2.5 m tall, trunk slender. *Bark* coarsely flaking or splitting to reveal a reddish or yellowish brown inner layer. *Branches* striate, ferruginous; new growth conspicuously striate, green, glutinous, lenticellate. *Stipules* in pairs, spinescent, 20–30 mm long, white, glabrous, slender, basally flattened, attenuate, pungent, antrorse, seldom arcuate, sometimes absent on new growth. *Leaves* fastigiate, shiny dark green, glabrous, glutinous when young, bipinnately compound, pulvinus vermilion at maturity; petiole sulcate, 5–15 mm long, with large, raised, crateriform, petiolar nectary gland; rachis sulcate, 20–90 mm long, with at least one nectary gland at junction of proximal and distal pinna pair; rachillae 3–6 pairs, distichous, 30–81 mm long, dotted with small dark glandular structures, with 8–16 leaflet pairs; leaflets distichous, narrowly elliptic, 6–15 × 2.4–3.0 mm, entire, eglandular, asymmetrical, apex mucronulate, base oblique, with conspicuous hyaline margin, midvein prominent on abaxial surface only, secondary veins not visible. *Inflorescences* capitate, globose, bright yellow, 10–22 mm diam., borne on new growth, fasciated on axillary peduncles; peduncle 70–90 mm long, glabrous or with few random, small dark glands, glutinous when young, often with shards of villose hairs; involucre bracteate, 1.0–2.2 mm long, 60–70 mm up the peduncle, 2 or 3 prominent, dark, gland-like tubercles usually present, remnants of a second involucre-like structure sometimes present ± 10 mm below flowers. *Flowers* bright yellow, dichlamydeous. *Bracteoles* clavate with apices covered by waxy globules. *Calyx* campanulate, pentamerous, glabrous, 1.0–2.1 mm long, ascending, usually with a few pustular waxy globules, apex crenulated. *Corolla* campanulate, pentamerous, membranaceous; lobes ± united, calceiform,

1.4–1.6 × 0.5–0.7 mm, ascending, edges and apex punctulate, usually with few pustular waxy globules. *Stamens* numerous; filaments 2–3 mm long. *Ovary* ventricose, septate, 1–2 mm long, surface with a few pustulate waxy globules; style 2–3 mm long. *Pods* dehiscent, complanate, eglandular, slightly falcate, 40–115 × 7–11 mm, 2–6-seeded, edges becoming constricted between seeds at maturity. *Seeds* elliptic, 6–9 × 4–7 mm, areole elliptic, 4–6 × 2–5 mm. Figure 10.

**Diagnostic features and affinities:** *Acacia ebutsiniorum* can immediately be distinguished from all other southern African yellow-flowered acacias, including *A. natalitia* E.Mey. and *A. karroo* Hayne, by its exceptionally long, 70–90 mm, peduncles and the distinct hyaline margin of the leaflets. The precise phylogenetic relationships of *A. ebutsiniorum* are obscure. Its constricted pods are vaguely reminiscent of those of *A. natalitia* (at times included under *A. karroo*) with which it occurs sympatrically. However, *E. ebutsiniorum* differs conspicuously from the latter in that its pods are much broader and more robust. Moreover, in the field it can readily be distinguished from *A. natalitia* by its much smaller stature and markedly glutinous new growth. *A. natalitia* tends to be a much bigger tree with the new growth never glutinous. Additional differences between these two species are provided by floret morphology. In *A. natalitia* the corolla lobes are fused into a short tube above the calyx, whereas in *A. ebutsiniorum* the lobes are much shorter and completely free.

*Acacia ebutsiniorum* superficially resembles *A. antunesii* Harms from the Huila Plateau of southern Angola in general appearance as well as shape and size of the leaves (Ross 1979). There are, however, marked differences in geographical distribution, plant size and morphology. Salient morphological differences between the two species are given in Table 1.

**Distribution and habitat:** at present *A. ebutsiniorum* is known from a single gregarious population at an altitude of 1 140 m in a mountainous area northeast of Oshoek,

TABLE 1.—Differences between *Acacia ebutsiniorum* and *A. antunesii*

|                | <i>A. ebutsiniorum</i>          | <i>A. antunesii</i> according to Ross (1979) |
|----------------|---------------------------------|--|
| Distribution   | eastern South Africa            | south-central Angola                         |
| Habit          | shrub or small tree up to 2.5 m | tree up to 6 m                               |
| Leaf surface   | glabrous, shiny                 | with dense grey indumentum                   |
| Petiolar gland | large, crateriform              | usually absent; if present, small            |
| No. leaflets   | 8–16 pairs                      | 11–19 pairs                                  |
| Leaflet margin | distinctly hyaline              | not distinctly hyaline, often ciliolate      |
| Calyx lobes    | apex crenulate, punctulate      | apex truncate, hairy                         |
| Corolla lobes  | margin punctate                 | margin hairy                                 |
| Pods           | slightly falcate, constricted   | straight, not constricted                    |



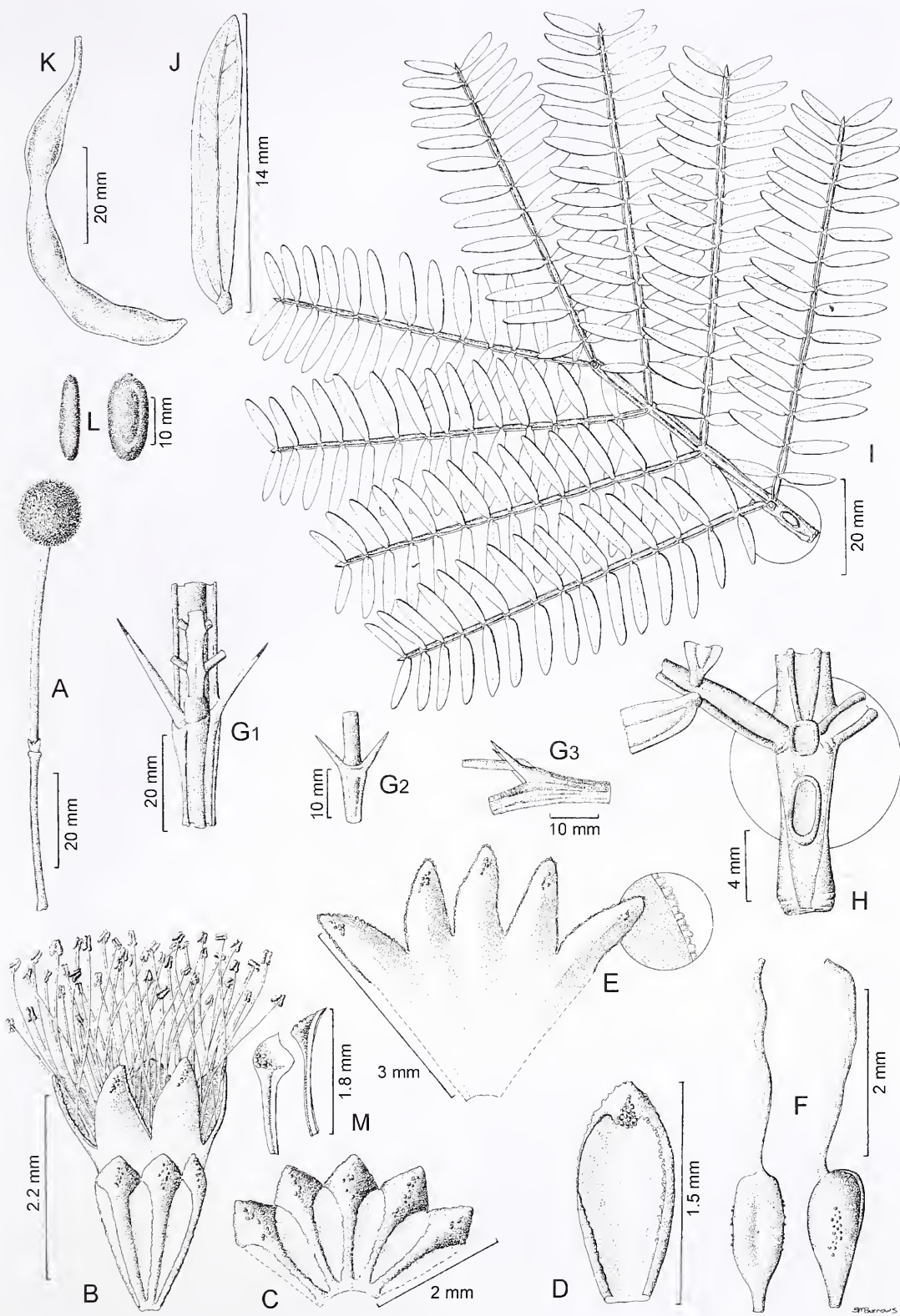


FIGURE 10.—*Acacia ebutsiniorum* P.J.H. Hurter. A, flower head; B, individual flower; C, calyx. D, calyx lobe; E, corolla; F, gynoecium; G<sub>1</sub>–G<sub>3</sub>, stipules; H, petiole; I, leaf; J, leaflet; K, pod; L, seed; M, bracteole. Scale bars: A, G<sub>1</sub>, I, K, 20 mm; J, 14 mm; G<sub>2</sub>, G<sub>3</sub>, L, 10 mm; H, 4 mm; E, 3 mm; B, 2.2 mm; C, F, 2 mm; D, 1.5 mm, M, 1.8 mm. Drawn from P.J.H. Hurter 133 spirit collection in PRU, by S. Burrows.



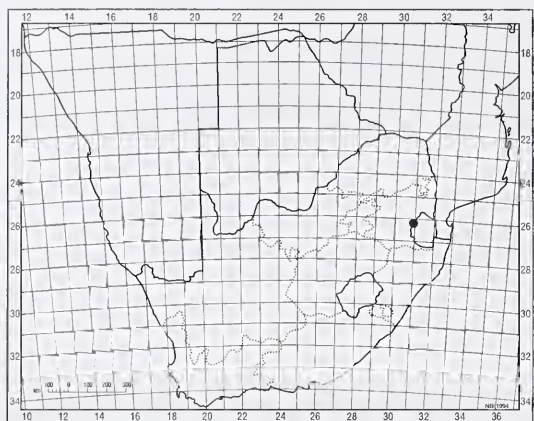


FIGURE 11.—Known distribution of *Acacia ebutsiniorum* in South Africa.

Mpumalanga (Figure 11). The plants grow in exposed, open grassland on a steep, southeast-facing slope, and are periodically subjected to fire. *A. ebutsiniorum* shares this habitat with several other newly discovered and still to be described plant taxa, all confined to its immediate vicinity. No earlier herbarium collections of the new species are known, which is hardly surprising considering the remoteness of the locality and the unique and apparently localized plant community of which it forms a part. It is possible that other populations might exist in seemingly similar habitats to the east of the present locality, but this could not yet be confirmed. The known range of the new species seems to fall just inside a local focus of plant endemism known as the Barberton Centre (Van Wyk & Smith 2001). This region is known for its many edaphic specialists, including taxa endemic to serpentine-derived soils. Although the precise geological identity of the rocks at the *A. ebutsiniorum* locality still needs to be established, it appears to be a type of serpentinite.

*Etymology*: the specific epithet commemorates the people of the Swazi-speaking Ebutsini Tribe living in the

area where the trees occur, in acknowledgement of their generous hospitality during field work and wealth of field knowledge they so freely shared with the first author; without their help this unique plant community could not have been discovered.

#### ACKNOWLEDGEMENTS

We are indebted to the curators of GRA, K, NBG, PRE, PRU, SRGH for access to their herbaria, Dr H.F. Glen for the Latin diagnosis, Sandie Burrows for the line drawing, Gerhard Strydom of the Mpumalanga Parks Board for assistance in the field, SABONET and the National Botanical Institute for financial assistance.

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## BORAGINACEAE

### A FIRST RECORD OF *ECHIMUM SIMPLEX* IN SOUTH AFRICA

#### INTRODUCTION

The Boraginaceae comprises ± 131 genera and 2 500 species of mainly annual or perennial herbs and shrubs, some trees and a few lianes (Brummitt 1992; Retief & Van Wyk 1997). The plants are widely distributed in tropical and especially subtropical and temperate regions, with major centres of diversity in the Mediterranean region and western parts of North America (Toelken 1986). In southern Africa the family is represented by 20 genera with 111 species, including 19 alien species regarded as naturalized in the flora of southern Africa (Retief 2003).

The genus *Echium* L. is one of the non-native genera of the Boraginaceae in southern Africa. Together with the seg-

regate genus *Pontechium* Böhle & Hilger, it is the northern hemisphere counterpart of the closely related genera *Lobostemon* Lehm. and *Echiostachys* Levyns, both endemic to the Cape Floristic Region of South Africa (Retief & Van Wyk 1997; Hilger & Böhle 2000; Van Wyk & Smith 2001). Phylogenetically *Echium* splits naturally into two distinct infrageneric groups or clades (Böhle *et al.* 1996; Hilger & Böhle 2000). The first group comprises ± 30 species of mainly herbaceous annuals to perennials. Geographically this group has a circummediterranean distribution, extending over most of Europe, reaching western Asia. The second group of 27 species is endemic to the Canary, Madeira and Cape Verde Archipelagos of the Macaronesian Islands. All but two of these island species are woody perennials and preferential outbreeders. Molecular data and geological evidence suggest that all the contemporary island dwellers are



FIGURE 12.—Terminal, many-flowered thyrse of *Echium simplex* kept as voucher specimen, Smith & Steyn 14 at PRE.

derived from herbaceous continental antecedents following a perhaps single founding colonization less than 20 million years ago (Böhle *et al.* 1996, but see Perez de Paz 1995 for evidence from palynology).

ECHIUM SPECIES IN SOUTHERN AFRICA

Two of the herbaceous continental European species of *Echium*, namely *E. plantagineum* L. and *E. vulgare* L., were previously discussed in detail (Retief & Van Wyk 1998). Both are naturalized in Western and Eastern Cape, eastern Free State, Lesotho, the high mountainous areas of KwaZulu-Natal and in Mpumalanga, where they mainly occur as annual weeds of roadsides and fallow fields. A member of the island group of species, *E. candicans* L.f.

(‘Pride of Madeira’), is widely grown as a garden ornamental in South Africa. Based on anecdotal evidence, it was somewhat doubtfully listed as a potential problem plant in the summer rainfall regions of South Africa (Wells *et al.* 1986). However, there is no evidence that this species has become naturalized in our region; its occurrence outside gardens is rare and accidental. The present paper deals with a fourth species, *Echium simplex* DC., another member of the group of island dwellers and recently reported from South Africa for the first time (Willis & Smith 2002).

*Echium simplex*, the ‘Pride of Tenerife’, is a rare endemic of the Canary Islands. With its basal rosette of silvery green leaves and massive, erect, up to 2 m tall inflorescence of several hundred pure white flowers, it is a most spectacular plant (Figures 12–14). In its native





FIGURE 13.—Population of *Echium simplex* thriving among coastal scrub near Hermanus in the southwestern Cape. Photograph: G.F. Smith.



FIGURE 14.—Apical part of inflorescence of *Echium simplex* with showy, pure white flowers. Photograph: G.F. Smith.

country, it is a coastal cliff species of low altitudes (100–400 m), restricted to humid habitats on basalt cliffs of the Anaga Mountains in the northeastern region of the island Tenerife (Bramwell 1972; Böhle *et al.* 1996). In a taxonomic revision of the Macaronesian members of *Echium*, Bramwell (1972) classifies *E. simplex* together with *E. pinimana* Webb & Berth. and *E. wildpretii* H.H.W. Pearson ex Hook.f. in section *Simplicia* (H. Christ ex Sprague & Hutch.) Bramwell. *E. simplex* has become naturalized in the flora of South Australia (Toelken 1986) where it thrives near Robe in the Mediterranean-like climate of the southeastern parts of the region. In 2001 the first author found a flourishing population of these alien plants in the veld among coastal scrub near the coastal town of Hermanus in the southwestern Cape, where the climate is also typically Mediterranean. This provenance is supported by a voucher specimen, *Smith & Steyn 14* (Figure 12) kept in the National Herbarium of South Africa (PRE). This strikingly beautiful plant was most probably introduced to South Africa as a garden ornamental. However, if indeed the case, this must have been an isolated event as we have no knowledge of the species being propagated by nurseries in the region and we have never observed it in a local garden.

In view of the ease with which species of *Echium* seem to overcome barriers to produce offspring freely and to sustain populations over many life cycles in the

southern African veld, *Echium simplex* should be regarded as a likely candidate for naturalization (*sensu* Richardson *et al.* 2000) in the flora of the southwestern Cape. On the other hand, this apparent ease of establishment may favour the potential agronomical use of *E. simplex*, and perhaps other Macaronesian members of the genus in the Cape. Seeds of these island species are one of the richest sources of gamma-linolenic acid [GLA] found in nature so far. GLA is a commercially important seed oil for which there is a growing demand in the food, cosmetic and pharmaceutical industries (Horrobin 1992; Guil-Guerrero *et al.* 2000, 2001). A single plant of *E. simplex* produces several thousand propagules, with seed oil comprising 10.04% of seed weight and containing 19.28% GLA (Guil-Guerrero *et al.* 2000).

7118000–00065 *Echium simplex* DC., *Catalogus plantarum horti botanici monspeliensis*: 108 (1813); Bramwell: 75 (1972); Bramwell & Bramwell: 184, t. 228 (1974); Toelken: 1156 (1986). Type: '*E. simplex* DC. hab. in Insula Teneriffa ex Herb. Broussonet', fide Bramwell (1972: 75) [MPU, non vidi, fide Bramwell (1972)].

Unbranched, monocarpic rosette plant, lasting 4–5 years. *Stem* woody, short in vegetative state, lengthening to  $\pm 1$  m during flowering. *Leaves* somewhat leathery, spirally arranged, crowded at tip of stem in vegetative state, sessile, elliptic-lanceolate, 200–220 mm long, 40–45 mm wide



at mid-blade, both surfaces silvery green, densely covered with silky, short, unicellular, small-based, appressed trichomes, veins on lower surface prominent. *Inflorescence* a terminal, dense, cylindrical thyse up to 600 mm long; lateral cymes in axils of leaf-like bracts, numerous, scorpioid, 1–5-fid, many-flowered, distinctly stalked; lateral peduncles 15–30 mm long, bracteate. *Flowers* sessile, actinomorphic, nectariferous, unscented, strongly protandrous. *Calyx* persistent, 5-partite, divided almost to base; lobes lanceolate,  $\pm 6$  mm long, acute, pubescent. *Corolla* white,  $\pm 10$  mm long, funnel-shaped, sparsely pubescent, 5-lobed; lobes equal, slightly spreading, rounded. *Stamens* silvery white, equal, strongly exerted, arising as single series at  $\pm 3$  mm from base of corolla tube; filaments glabrous, cylindrical,  $\pm 11$  mm long; anthers versatile, small,  $\pm 2$  mm long before dehiscence, splitting lengthwise; pollen silvery white. *Ovary* deeply 4-lobed; style simple, gynobasic, exerted beyond anthers; stigma bifid. *Fruit* a schizocarp consisting of four greyish brown nutlets; nutlets  $\pm 2.7 \times 2$  mm, tuberculate with tubercles varying in size, convex on dorsal side, keeled on ventral side,  $\pm$  triangular at base.

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## MESEMBRYANTHEMACEAE

## A NEW TRIBE AND ADJUSTMENTS TO INFRAFAMILIAL CLASSIFICATION

Recently the tribal classification of Mesembryanthemaceae Fenzl has been the focus of attention in contributions based on both morphological (Chesselet *et al.* 2001, 2002) and molecular (Klak *et al.* 2003) evidence. Molecular data provides an independent character set for testing the congruence of morphological characters. When contrasting these data sets we find that molecular data largely support the broad infrafamilial classification based primarily on nectary type proposed by Chesselet *et al.* (2002), except in the case of tribe Delospermeae (Figure 15).

*Delosperma* N.E.Br. ( $\pm 163$  species) and *Drosanthemum* Schwantes ( $\pm 120$  species) are the largest of several genera placed by Chesselet *et al.* (2002) in the Delospermeae. Klak *et al.* (2003), however, do not maintain

the Delospermeae, but place all taxa assigned to this tribe in an expanded concept of Ruschieae (Chesselet *et al.* 2002). Although the molecular phylogeny of Klak *et al.* (2003) is not fully resolved, four distinct clades do emerge for subfamily Ruschioideae, three of which are formally recognized taxonomically by these authors. The fourth clade includes all investigated members of *Drosanthemum* and a single species of *Delosperma*, namely *D. asperulum* (Salm-Dyck) L.Bolus (= *Drosanthemum asperulum* (Salm-Dyck) Schwantes). The latter taxon has since been transferred back to *Drosanthemum* by Klak (2003) on the grounds that it resolves with *Drosanthemum* in a distinct evolutionary lineage within the tribe Ruschieae (Klak *et al.* 2003). This clade is, however, not given any formal taxonomic status despite it having 95% bootstrap support in a strict

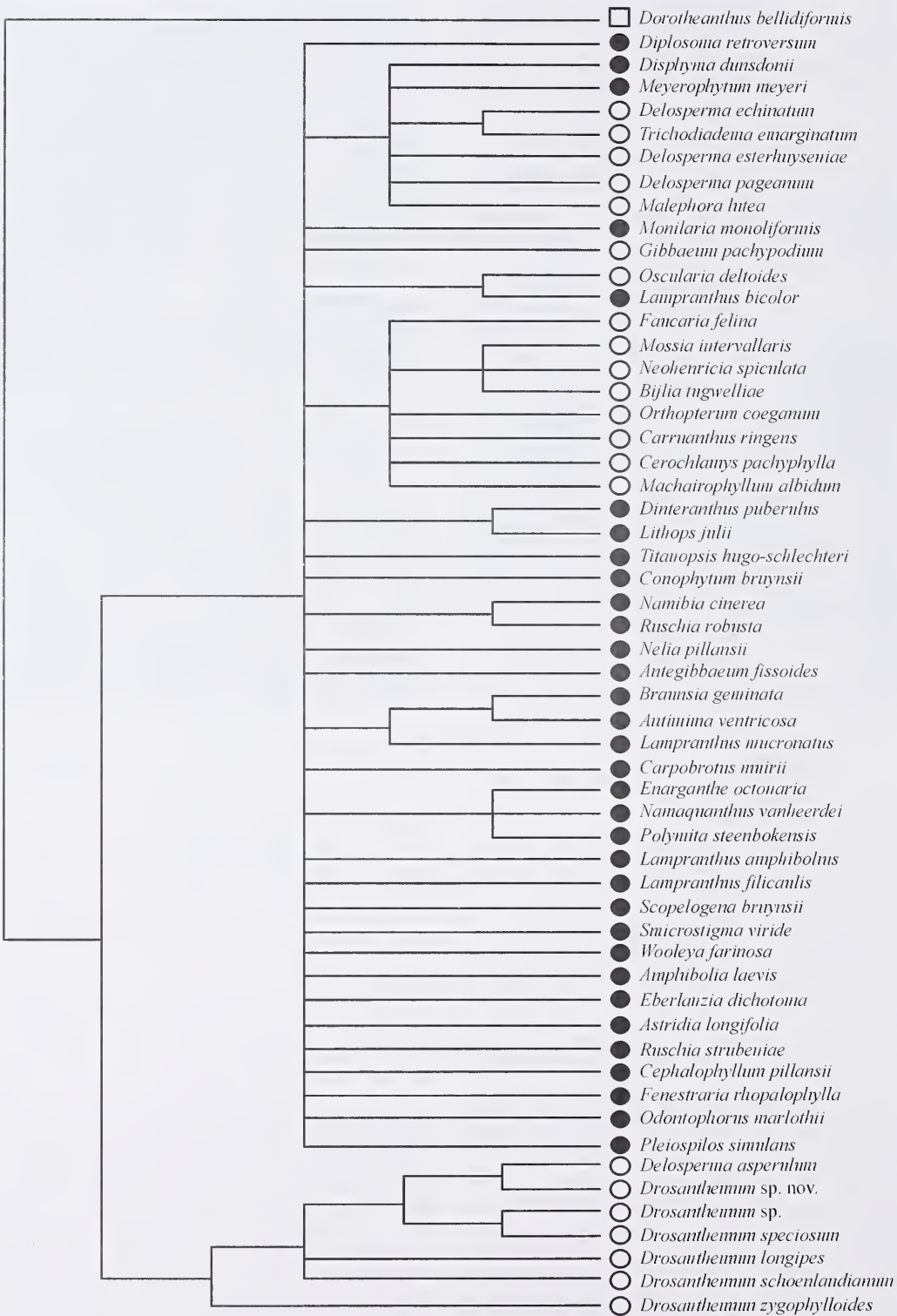


FIGURE 15.—Nectary characters from Chesselet *et al.* (2002) plotted on molecular phylogeny for mesembs from Klak *et al.* (2003). The most striking result is that the *Delosperma* Group of Hartmann (1991, 1993) is polyphyletic. Note the molecular resolution obtained for members of the newly described tribe Drosanthemeae in contrast to polytomy obtained for the Ruschieae, indicating the greater age of the former group. Members of the *Bergeranthus* and *Stomatium* groups of Hartmann (1991, 1993) resolve as a distinct clade within Ruschieae and are characterized by a lophomorph meronectary. Key: □, broad flat meronectary; ○, lophomorphic meronectary; ●, lophomorphic holonectary.

consensus tree of the 5000 most parsimonious trees based on a four-gene-region analysis. Here we propose the latter clade as a distinct new tribe, the Drosanthemeae. The molecular phylogeny nevertheless shows that some other *Delosperma* species as well as several other genera included in Delospermeae by Chesselet *et al.* (2002) are clearly better placed in Ruschieae.

The most unexpected result of the molecular phylogeny provided by Klak *et al.* (2003) is that the 'Delosperma group' of Hartmann (1991, 1993) is polyphyletic. Since Schwantes (1947), in his *System der Mesembryanthemaceae*, defined Subtribe Delospermatinae, *Delosperma* and *Drosanthemum* have been uncritically associated with each other. Despite the simple hygrochastic fruit, papillate epidermis, often broad, flat mesophytic leaves, and an exceptionally wide (for mesembs) distribution range that extends from southern Africa to East Africa and the Indian Ocean islands of Reunion and Madagascar, the genus *Delosperma* is not as 'primitive' as has been widely accepted. In contrast, *Drosanthemum*, with its characteristic basally-free leaves that bear large, water-filled bladder cells, emerges as being more basal than hitherto surmised. The wide distribution range of *Drosanthemum* and its strong presence in the Fynbos Biome supports this hypothesis. Recently, Chesselet *et al.* (2003) argued that basal tribes in Ruschioideae have their origins in the Fynbos Biome, which is considered the older biome in relation to the Succulent Karoo (Stuckenberg 1998).

At present the distinct clade named here as tribe Drosanthemeae contains the single genus *Drosanthemum*. Following extensive work on the flowers and fruit of *Drosanthemum* (Hartmann & Bruckmann 2000; Rust *et al.* 2002) a single possible synapomorphy involving the fruit stalk was found for the genus. *Drosanthemum* is a large and morphologically heterogeneous taxon characterized by no less than 13 different fruit types and five floral types. Congruence between these character sets exists in only three cases. The genus remains one of the most problematic in terms of identification. The fact that some *Drosanthemum* species tend to show free leaves, supports their more primitive position in the phylogeny. This characteristic is shared with other more primitive ruschioid taxa in tribes Apatesieae and Dorotheanthae and it can thus be regarded as a symplesiomorphic feature. *Enarganthe* N.E.Br. is reported to have basally-free leaves (Brown 1930), although examination of leaf material does not confirm this unambiguously. We therefore consider basally fused leaves as a possible synapomorphy for tribe Ruschieae (Figure 16). Those species of *Drosanthemum* that appear to have leaves that are fused at the base may indicate convergence with taxa in Ruschieae.

Both *Delosperma* and *Drosanthemum* are characterized by flowers with a 'lophomorphic meronectary' and were placed by Chesselet *et al.* (2002) in Delospermeae together with all other genera with this type of nectary. The inclusion, into this tribe, of the *Bergeranthus* and *Stomatium* groups of Hartmann (1991, 1993), was counter-intuitive, though justified according to the principle of parsimony, in the absence of other character sets at the time. The molecular study of Klak *et al.* (2003) has shown that taxa belonging in the latter two groups are

better placed in tribe Ruschieae. The presence of a lophomorphic meronectary indicates a possible reversal, switching of major genes or the persistence of the plesiomorphic condition in genera allied to *Bergeranthus* and *Stomatium*.

Following the reassessment of the tribal classification based on nectary types and together with insights gained from molecular data, we propose the following nomenclatural adjustments. For a comprehensive tribal classification refer to Chesselet *et al.* (2002).

**Drosanthemeae** Chesselet, Gideon F.Sm. & A.E.van Wyk, trib. nov. Type: *Drosanthemum* Schwantes

Plantae perennes. Paria foliorum plerumque basi disc-reta; folia saepeque caules plerumque cum cellulis vesicariis prominentibus vel pilis. Flores semper cum meronectariis lophomorphis. Capsulae hygrochasticae, plerumque 5(6)-carpellatae, interdum cum locellis seminalibus basalibus.

Plants perennial. *Leaf pairs* mostly basally free, leaves and often stems, usually with prominent bladder cells or hairs. *Flowers* always with crested or lobed (lophomorphic) separate nectaries (meronectary). *Capsules* hygrochastic, usually 5(6)-carpellate sometimes with basal seed chambers.

Includes tribe Delospermeae Chesselet, Gideon F.Sm. & A.E.van Wyk p.p.

Includes subtribe: Delospermatinae Schwantes p.p.

Comprises the *Delosperma* Group of Hartmann (1991, 1993) p.p.

Genera: *Drosanthemum* [at least as to species investigated by Klak *et al.* (2003)]. Note: the inclusion of additional species currently placed in *Delosperma* and/or *Mestoklema* is uncertain at this stage, as is the possible exclusion of some species currently placed in *Drosanthemum*.

**Ruschieae** Schwantes in Ihlenf., Schwantes & Straka in Taxon 11: 54 (1962), emend. Klak, Khunou, Reeves & Hedderson: 1443 (2003). Type: *Ruschia* Schwantes. Note: the spelling of 'Ruschiae' in Klak *et al.* (2003) is an orthographic error.

Plants perennial, sometimes with enlarged rootstock. *Leaves* mesomorphic or xeromorphic, always basally fused, with or without prominent bladder cells and/or hairs or with homocellular or heterocellular xeromorphic surfaces. *Flowers* with crested or lobed (lophomorphic) separate nectaries (meronectary) or annular nectaries (holonectary). *Capsules* hygrochastic, rarely with reduced expanding keels, and breaking up when dry (schizocarpic); *fruit* rarely a berry.

Comprises the *Bergeranthus*, *Delosperma* p.p., *Dracophilus*, *Eberlanzia*, *Lampranthus*, *Leipoldtia*, *Mitrophylum*, *Ruschia*, *Stomatium* and *Titanopsis* Groups of Hartmann (1991, 1993).



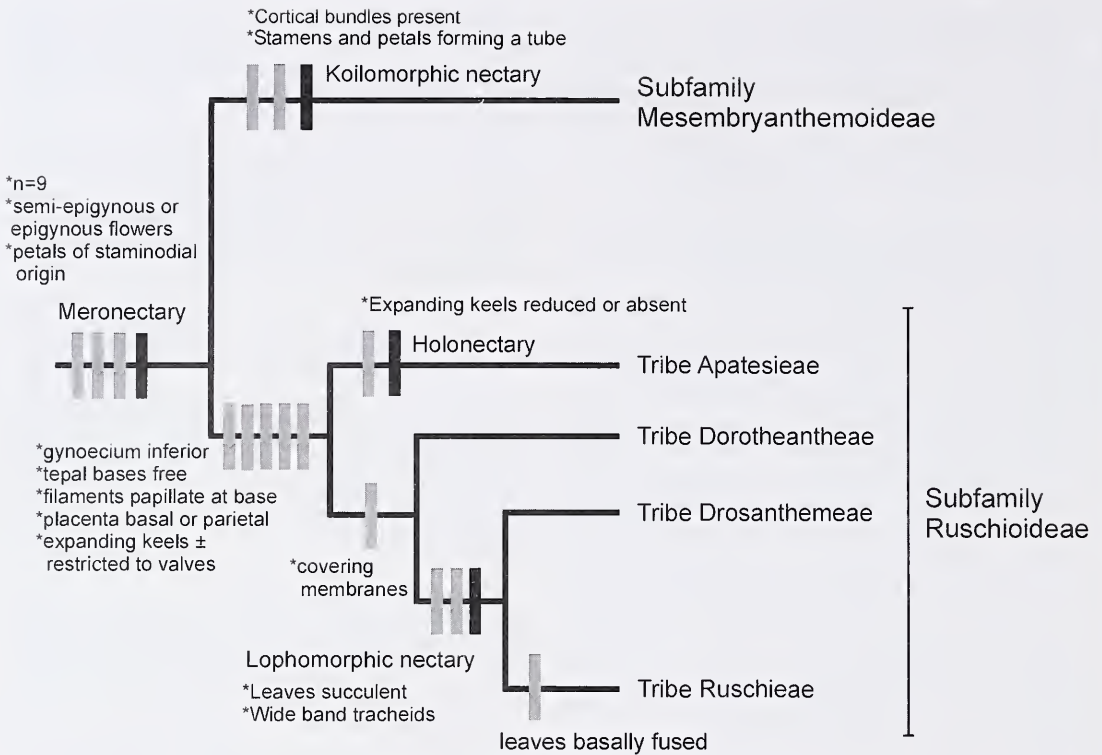


FIGURE 16.—Cladogram of the basal groups of Mesembryanthemaceae. The previously named tribe Delospermeae has been replaced with Tribe Drosanthemeae. Genera previously included in Delospermeae have been redistributed in Drosanthemeae and Ruschieae. From Chesselet *et al.* (2002), with modification. Note: characters of the floral nectary indicated as black bars.

Includes subtribes: Carpobrotinae Schwantes, Conophytinae Schwantes, Delospermatinae Schwantes p.p., Dracophilinae Schwantes, Erepisinae Schwantes, Faucarinae Schwantes, Frithiinae Schwantes, Gibbaeinae Schwantes, Jacobseniinae Schwantes, Jensenobotryinae Schwantes, Leipoldtiinae Schwantes, Lithopinae Schwantes, Lampranthinae Schwantes, Malephorinae Schwantes, Mitrophyllinae Schwantes, Nananthinae Schwantes, Pleiospilinae Schwantes, Psammophorinae Schwantes, Ruschiinae Schwantes, Stoeberiinae Friedrich, Stomatinae Schwantes.

Genera: *Acrodon*, *Aloinopsis*, *Amphibolia*, *Antegibbaeum*, *Antimima*, *Arenifera*, *Argyroderma*, *Astridia*, *Bergeranthus*, *Bijlia*, *Braunsia*, *Carpobrotus*, *Carruanthus*, *Cephalophyllum*, *Cheiridopsis*, *Cerochlamys*, *Chasmatophyllum*, *Circandra*, *Conophytum*, *Corpuscularia*, *Cylindrophyllum*, *Deilanthus*, *Delosperma*, *Dicrocaulon*, *Didymaotus*, *Dinteranthus*, *Diplosoma*, *Disphyma*, *Dracophilus*, *Eberlanzia*, *Ebracteola*, *Ectotropis*, *Enarganthe*, *Erepisia*, *Esterhuysenia*, *Faucaria*, *Fenestraria*, *Frithia*, *Gibbaeum*, *Glottiphyllum*, *Hallianthus*, *Hammeria*, *Hartmannanthus*, *Hereroa*, *Ihlenfeldtia*, *Jacobsenia*, *Jensenobotrya*, *Jordaaniella*, *Juttadinteria*, *Khadia*, *Lampranthus*, *Lapidaria*, *Leipoldtia*, *Lithops*, *Machairophyllyum*, *Malephora*, *Marlothiella*, *Mestoklema*, *Meyerophyllum*, *Mitrophyllum*, *Monilaria*, *Mossia*, *Muiria*, *Namaquanthus*, *Namibia*, *Nauanthus*, *Nelia*, *Neohewicia*, *Octopoma*, *Odontophorus*, *Oophytum*, *Orthopterum*, *Oscularia*, *Ottosonderia*, *Pleiospilos*, *Polymita*, *Psammophora*, *Rabiea*, *Rhinephyllum*, *Rhorabophyllum*, *Ruschia*, *Ruschii-*

*anthemum*, *Ruschianthus*, *Schlechteranthus*, *Schwantesia*, *Scopelogenia*, *Snicrostigma*, *Stayneria*, *Stoeberia*, *Stomatium*, *Tanquana*, *Titanopsis*, *Trichodiadema*, *Vanheerdea*, *Vanzijlia*, *Vlokia*, *Wooleya*, *Zeuktophyllum*.

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# Functional and taxonomic significance of seed structure in *Salix mucronata* (Salicaceae)

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**Keywords:** anemochory, Flacourtiaceae, hilar aril, hydrochory, plumed seed, rheophyte, Salicaceae, *Salix mucronata*, seed adaptations, taxonomy

## ABSTRACT

The polymorphic African willow, *Salix mucronata* Thunb., is a widely distributed African tree and a riparian rheophyte. Ovule-to-seed development is reported for *Salix mucronata* subsp. *woodii* (Seemen) Immelman. Contrary to some existing reports, the tuft of silky hairs enveloping the seed in *Salix* is derived from the funicle and not the placenta. The micromorphological structure of the hilar aril and funicular-placental and arillate hairs is described and illustrated for the first time. Willow seeds are primarily wind-dispersed, but have additional characters, such as a hydrophobic seed coat and an unwettable, hairy, hilar aril as specific adaptations for distribution by water, perhaps even chance dispersal by animal visitors to the riverine habitat. Seed adaptations linked to different dispersal strategies may account for seemingly marked differences in ovule/seed structure between Salicaceae *s. str.* and related, mainly zoochorous flacourtiaceous taxa, recently classified with the former in a more inclusively circumscribed Salicaceae *s.l.*

## INTRODUCTION

Salicaceae, a classical family recently drastically redefined and classified in the order Malpighiales (Chase *et al.* 2002), is now considered a cosmopolitan group comprising about 53 genera with  $\pm$  2 415 species of woody perennials. Apart from *Salix* L. (willows) and *Populus* L. (poplars, cottonwoods), the two genera traditionally making up the family (Salicaceae *s.str.*), the newly proposed circumscription now also includes most of the genera formerly placed in Flacourtiaceae *sensu* Lemke (1988). With 400–450 species included in *Salix*, this speciose genus of dioecious, catkin-bearing shrubs and trees is by far the largest in Salicaceae *s.l. sensu* Chase *et al.* (2002).

*Salix*, commonly known as willows, is the most widely dispersed genus in the family. Currently, most willow species occur in cold temperate to arctic regions of the northern hemisphere, but some grow in warm temperate to tropical climates (Wilmot-Deane 1985, 1991; Friis 1992; Judd *et al.* 2002) where the genus possibly originated (Skvortsov 1968; Dorn 1976). The genus is absent from Australasia and New Guinea (Wilmot-Deane 1985), a few species are found in South America (Zuloaga & Morrone 1999) and one species occurs naturally in Africa (M. Jordaan pers. comm.). This African species, *Salix mucronata* Thunb. (= *S. subserrata* Willd.) is widely distributed, extending from southern Arabia (McKean 1996) and Egypt southwards to Senegal and southwards through Ethiopia to Namibia and South Africa (Friis 1992). It is a polymorphic species and, in southern Africa, four (Coates Palgrave 2002; Jordaan 2002) or five (Immelman 1987) subspecies are recognized.

Characteristically, *Salix* prefer wet to moist, open habitats (Judd *et al.* 2002). In almost all African phytochoria,

representatives of the genus are riverine in distribution (Friis 1992). Indeed, many *Salix* species throughout the world are riparian rheophytes, i.e. plants growing along swift-running watercourses and on the banks up to flood level, but not beyond the reach of regularly occurring flash floods (Van Steenis 1981; Jordaan 2002). One such species is the widely dispersed African endemic, *S. mucronata* (Van Steenis 1978).

It is generally assumed that the plumed seeds of willows are wind-dispersed (Ridley 1930; Van der Pijl 1969; Johri *et al.* 1992; Judd *et al.* 2002), but the issue is whether wind is the principal dispersal agent involved in the wide geographical distribution of *S. mucronata*. Our observations on seed dispersal in *Salix mucronata* subsp. *woodii* (Seemen) Immelman showed that upon shedding, the seed does not remain airborne for long, despite the cover of loose wool that initially surrounds the seed and expedites its release from the capsule. In this contribution we present data on seed structure, supplemented by a study of capsule and seed development, suggesting that although willows are adapted to wind dispersal, the seed has additional modifications for dispersal by water and fortuitously by waterfowl or other animal visitors to the rheophytic habitat. We also comment on the taxonomic significance of seed structure in *Salix*, considering its recent association with members traditionally placed in Flacourtiaceae.

## MATERIAL AND METHODS

Catkins in most developmental stages were collected from a female tree of *S. mucronata* subsp. *woodii* (accession number: GPTA 495) in the Pretoria National Botanical Garden. The plant was grown from seed, collected by Dr L.E. Codd in 1953 from a tree (Codd 8246 PRE) on the bank of the Buffalo River, Natal [KwaZulu-Natal]. Floral buds, mature flowers, developing fruit and dehiscing capsules were fixed in a 0.1 M cacodylate-buffered solution (pH 7.4) containing 2.5% glutaraldehyde and 4% formaldehyde. Standard procedures were followed for dehydrating, infiltrating and imbedding the material in glycol methacrylate (GMA). For light microscope (LM) study,

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sagittal sections of ovules and seeds were obtained by sectioning flowers and capsules longitudinally, perpendicular to the subtending bract. Selected sections were stained with the periodic acid/Schiff reaction and counterstained with toluidine blue O (pH 4.4) by using the protocols of O'Brien & McCully (1981). Seed with mature embryos were obtained from herbarium sheets (*Codd 8246* PRE; *Obermeyer TM31027* PRE) and processed for GMA sectioning and staining as described above.

Tests for flight distance of seed were performed on windy days in an open part of the Pretoria National Botanical Garden. Dehiscent capsules containing wool-covered, fertile seed were collected from *Codd 8246* and *Obermeyer TM31027*, held between tweezers and exposed to the wind. Sterile 'seed' (unfertilized, shriveled ovules covered in wool) produced by Tree No. GPTA 495 were tested on the same days. Tests for wetability and buoyancy were conducted indoors by blowing loose wool and plumed, fertile seed onto the surface of muddy or clear, distilled water kept in containers in the laboratory and noting the flotation period.

For scanning electron microscope (SEM) studies, seeds from the above-mentioned herbarium specimens were carefully removed from dehiscing capsules, stuck onto aluminum stubs, sputter-coated with gold and viewed in an ISI SX 25 SEM.

## RESULTS

### *Placentation, development and structure of ovules*

Catkins on female trees contain a varying number ( $\pm 10$ –50) of flowers. Each flower is borne in the axil of a bract and consists of an adaxial nectary and a syncarpous, bicarpellate gynoecium (Figure 1A). The two carpels of the salicaceous pistil meet in the medium plane of symmetry of the flower (Meeuse 1975: 450) so that the parietal placentae, developing on the fused margins of the carpels, lie in this plane (Figure 1A). The ovuliferous zones of the placentae are restricted to the lower half of the unilocular ovary where eight to twelve ovules are formed.

Ovule primordia at the onset of meiosis (Figure 1B) were found inside floral buds still completely covered by the subtending bracts. In sagittal section (Figure 1A, B), such primordia consist of a large funicle, a developing outer integument (Corner 1976: 237) and a nucellus containing an enlarging megaspore mother cell covered by at least three layers of parietal nucellar cells (Figure 1A). An inner integument is absent, without any vestiges remaining. Meiosis results in four megaspores of which the chalazal one becomes functional (Figure 1C). Linear tetrads were not found in our material; the three micropylar megaspores lie obliquely to one another and possibly represent a stage intermediate between linear and T-shaped tetrads. At the completion of the meiotic process the integument has reached its full length, it covers the nucellus and forms the micropyle (Figure 1C).

Mature ovules are small ( $\pm 20$ –25  $\mu\text{m}$  in length, funicle excluded), anatropous and ovoid (Figure 2A). The lengths of the funicles vary (compare Figure 2A & C); ovules in the basal-parietal position usually have much shorter funicles than ovules nearer to the style. The

integument consists of three to four layers of thin-walled parenchyma. After the elements of the eight-nucleate embryo sac have been formed, the tip of the sac keeps intruding into the micropylar nucellus, later breaking through the nucellus epidermis and reaching the inner opening of the micropyle canal (Figure 2B).

During the elongation of the embryo sac, a plate-like intercalary meristem develops in the distal part of the funicle, forming a narrow band of flattened cells directly below the ovular body (Figure 2A). This region eventually forms a small, ring-like structure in the hilar region of the seed (see further on). At a slightly later stage, the epidermis cells of the placenta, funicle and hilar meristem form long, unicellular, intra-ovarian hairs, but the surface of the enlarging ovule remains glabrous (Figure 2C). In developing capsules collected from the female tree (GPTA No. 495) fertilization did not take place and the ovules aborted (Figure 2D). In such ovules the cells of the hilar meristem have disintegrated (Figure 2D). Seed abscission takes place at the funicular side of the aborted meristem so that the greater part of the funicle remains connected to the placenta (Figure 2C, D).

It is interesting that the capsule with its intra-ovarian hairs keeps developing and later dehisces in a normal manner, despite the abortion of the ovules. This parthenocarpic development of *Salix* capsules deserves further investigation.

### *Structure of the plumed seed and seed coat*

SEM micrographs of fertile seed taken from herbarium sheets (*Codd 8246* PRE; *Obermeyer TM31027* PRE) show a small, annular structure with numerous long hairs attached to its perimeter, positioned at the micropylar side of the seed (Figure 3A, D). These hairs form the plume or coma on the seed. The free underside of the ring has a rough surface of broken cells (Figure 3B). When eased away from the seed (Figure 3C), the upper (micropylar) side of the ring displays an entire, glabrous exterior (Figure 3D), suggesting that the ring has enveloped the base of the seed, without forming an integral part of it. In structure, origin and position the hairy hilar ring represents a kind of seed appendage known as a funicular or hilar aril (Boesewinkel & Bouman 1984: 592). We propose that this ring has developed from the hilar meristem in the distal part of the funicle and, during abscission of the seed, has broken away from the funicle.

Seeds are small (1.3–1.6 mm long), exalbuminous and contain straight, chlorophyllous embryos almost filling the embryo sac, except for an air space underneath the seed coat (Figure 3E). The seed coat is undifferentiated and the number of layers has not increased during ovule-to-seed development (compare Figures 2A, B; 3E). The outer epidermis has unevenly thickened outer periclinal walls and, in surface view, the uneven thickenings form an irregular micro-morphological pattern (Figure 4A). Between the thickened parts of the walls the thinner parts collapse so that numerous, minute depressions are formed on the seed surface (Figure 4A).

The hairs on the aril resemble the placental-funicular hairs (loose wool) and consists of a mass of seemingly



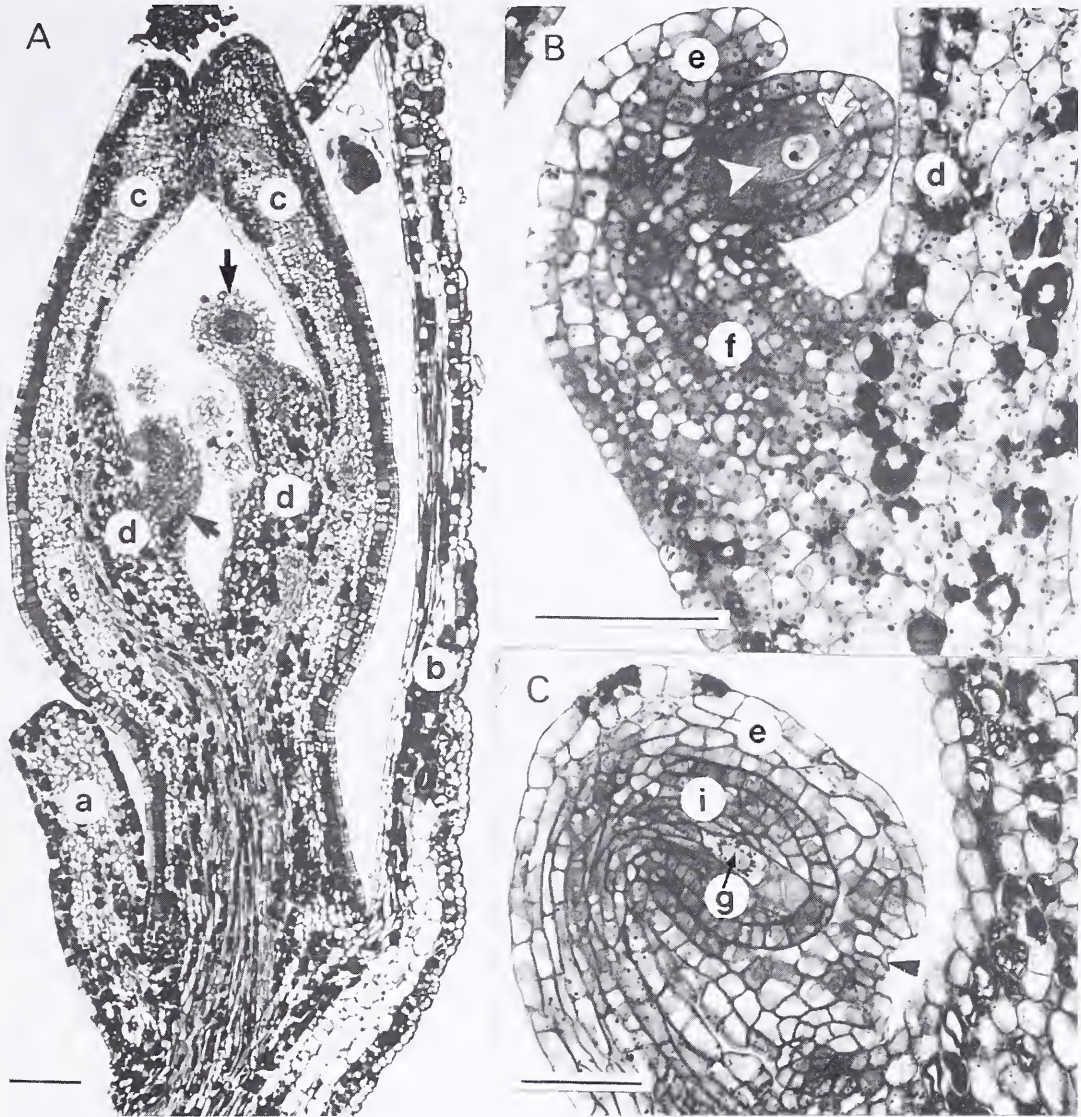


FIGURE 1.—Structure, position and placentation of ovules in *Salix mucronata* as seen in median sagittal sections. A, young female flower, note stalked ovule primordia (black arrows); B, ovule primordium in megaspore mother cell stage (white arrowhead) showing parietal nucellar cells (curved white arrow); C, young, anatropous ovule in megaspore tetrad stage, position of micropyle indicated by black arrowhead. a, adaxial nectary; b, subtending bract; c, bicarpellate ovary; d, parietal placenta; e, integument; f, funicle; g, functional chalazal megaspore; i, nucellus. Scale bars: A, 100  $\mu$ m; B, C, 50  $\mu$ m.

structureless, cylindrical fibres about 3–4 mm long, with smooth, transparent, thin walls without pits (Figures 3A–D; 4B). The walls stain blue-green with toluidine blue and yellow with aniline sulfate, indicating the presence of lignin. The fibres taper to a point and have a slightly bulbous base. When immersed in water, numerous air bubbles are trapped in the wide lumen (Figure 4B).

*Distance of flight, buoyancy and wettability of seeds and hairs*

Experiments in the garden and laboratory showed that fertile, wool-covered seeds do not remain airborne for more than ten metres in a moderately strong wind; after the loose

wool (intra-ovarian hairs supporting the seed) has been blown apart, the seed with hairy aril (plume) still attached, slowly descends. The flight distance of sterile ‘seeds’ could not be determined; they flew away so fast that they could not be retrieved. When the wool-covered seed lands in water, the loose hairs rapidly float away, but the plume remains attached to the seed. Loose wool, plumed seed and deplumed seed remain buoyant in clear and muddy water until the water in the containers has evaporated (about five days). The seed coats of floating seeds are unwettable (hydrophobic) and appear translucent white in water because of the numerous, minute air bubbles trapped in the depressions of the outer periclinal wall. By the time the muddy water in the containers has evaporated, the plumes have got stuck in the mud and the seeds separate easily from the arils.



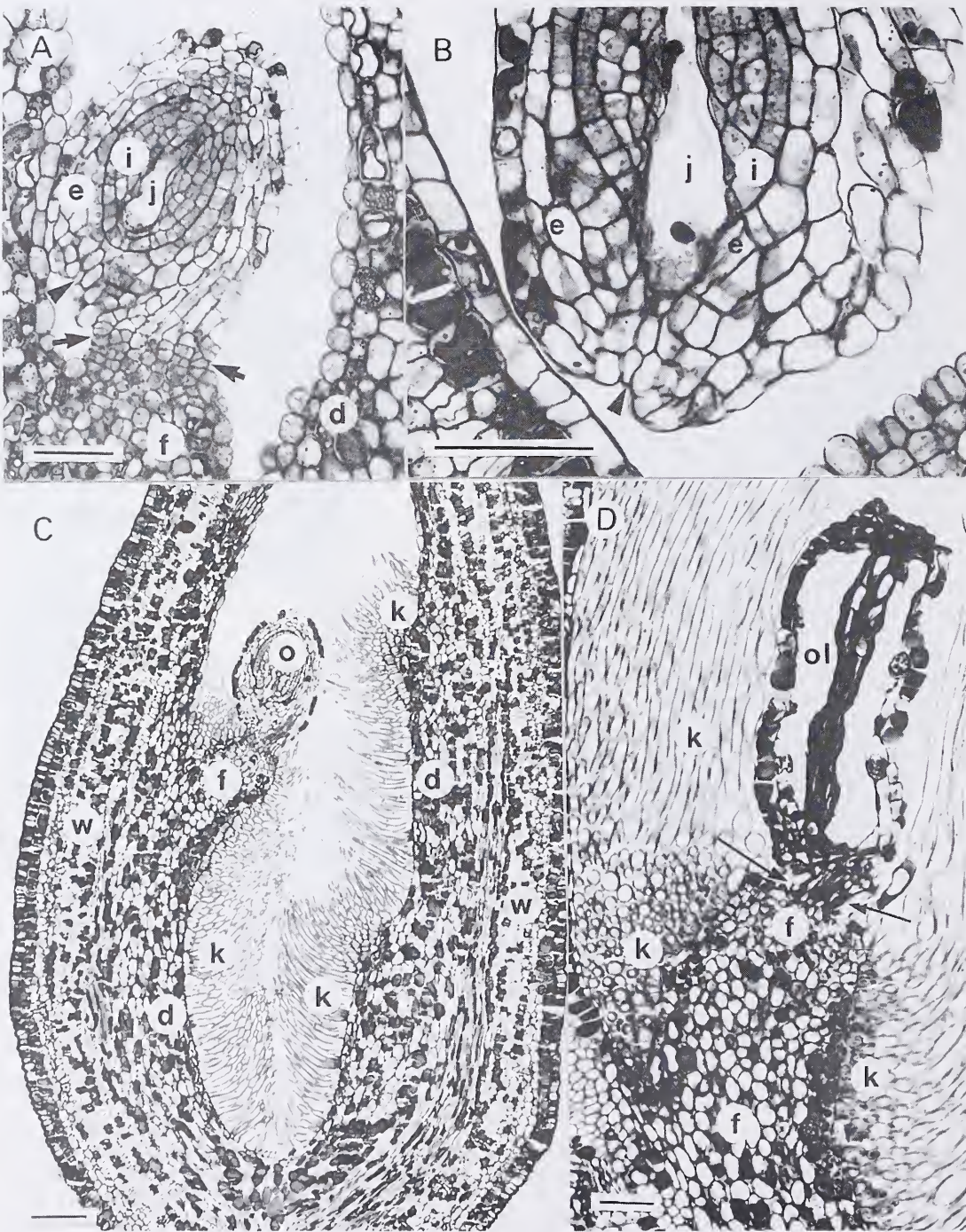


FIGURE 2.—Development of ovule and intra-ovarian hairs in *Salix mucronata*. A, mature ovule in sagittal section showing hilar meristem (black arrows) in distal part of funicle; B, l/s micropylar part of ovule with tip of embryo sac breaking through epidermis of nucellus, but staying inside integument; C, l/s developing capsule showing intra-ovarian hairs originating from placenta and funicle. D, part of sterile capsule with abortive, stalked ovule imbedded in intra-ovarian hairs, note position of disintegrated hilar meristem (small black arrows), black arrowhead indicates position of micropyle. e, integument; f, funicle; i, nucellus; j, embryo sac; k, intra-ovarian hairs; o, ovule; ol, abortive ovule; w, ovary wall. Scale bars: A, B, D, 50  $\mu$ m; C, 100  $\mu$ m.



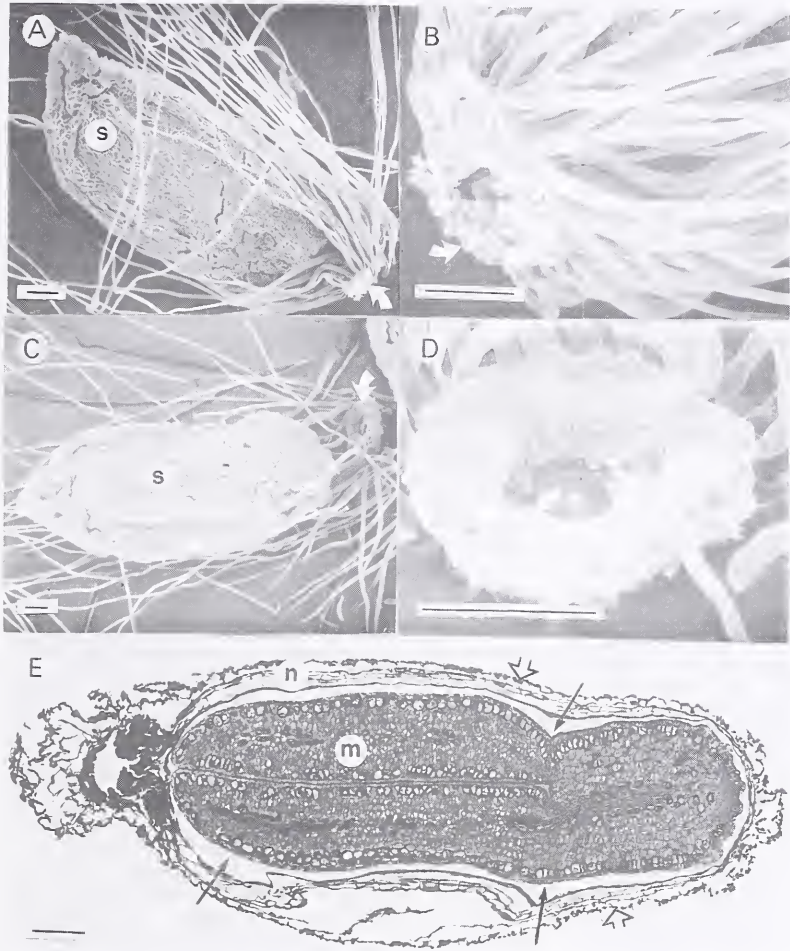


FIGURE 3.—Seed structure in *Salix mucronata* as seen in SEM micrographs (A–D) and LM photographs (E). A, plumed seed with coma of hairs attached to hilar aril; B, micropylar seed region showing aril and hairs at higher magnification than in A; C, aril detached from micropylar part of seed; D, aril as seen from above at higher magnification than in C; E, 1/s fertile seed showing large chlorophyllous embryo surrounded by air space (black arrows), note irregular wall thickenings (open black arrow) on outer periclinal walls of epidermis, curved white arrow, aril; m, embryo; n, undifferentiated seed coat; s, seed. All scale bars: 100  $\mu$ m.

DISCUSSION

*The coma of hairs on Salix seed*

It has often been alleged that the tuft of silky hairs enveloping the seed of willows is placental in origin (Takeda 1936; Van der Pijl 1969; Corner 1976; Johri *et al.* 1992). Others (Ridley 1930; Wilmot-Dear 1991; McKean 1996; Boulos 1999) mention that the hairs are derived from the funicle. Our observations on ovule-to-

seed development in *Salix* lend support to the latter view: sagittally sectioned, developing capsules distinctly show the presence of stalked ovules with the coma of hairs resulting from epidermal cells on the most distal part of the funicle. Takeda's (1936) erroneous conclusion that *Salix* ovules have no funicles and that the hairy tuft on the seed is part of the placenta was based on incorrectly sectioned capsules. His line drawings (Takeda 1936: 285, figs 1 & 4) show ovules in longitudinal (not sagittal) section in which the funicular connections to the placenta

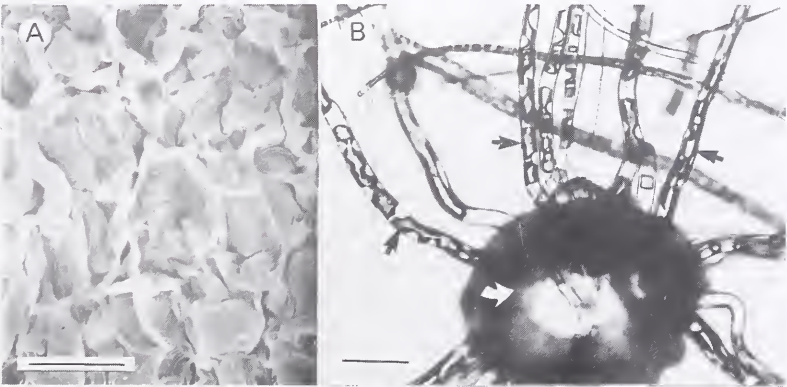


FIGURE 4.—Seed structure in *Salix mucronata* as seen in SEM micrograph (A) and LM photograph (B). A, structure of seed surface; B, hilar aril (curved white arrow) with air-filled hairs (black arrows). Scale bars: A, 20  $\mu$ m; B, 50  $\mu$ m.

were not visible. Later, well-known embryologists (Van der Pijl 1969; Corner 1976; Johri *et al.* 1992), accepted Takeda's (1936) interpretation, without re-investigating the matter.

The present report provides the first evidence for the occurrence of arillate seeds in *Salix*. The presence of hairy arils in Salicaceae was suspected, but not substantiated by Corner (1953), or mentioned in subsequent work (Corner 1976) and was not reconcilable with the supposed placental origin of the coma (Van der Pijl 1969). Since it is from the narrow distal region of the funicle that the small, annular and tufted aril arises and breaks away to form an appendage to the seed during seed abscission, we have referred to it as a hilar aril.

The micromorphological structure of the funicular-placental and arillate hairs in *Salix* is here described and illustrated for the first time. LM photographs and SEM micrographs show the mass of hairs consisting of cylindrical, structureless, unpitted, lignified and thin-walled fibres that remain filled with air when immersed in water. In these characters, *Salix* fibres closely resemble those found in the capsules of Bombacaceae, e.g. *Ceiba pentandra* Gaertn. (kapok tree) and *Bombax malabaricum* DC. (Indian kapok or Semal tree) as described by Kirby (1963: 389) and Ilvessalo-Pfäffli (1995: 358) and in *Chorisia speciosa* A.St.-Hil., the silk-floss tree (E.M.A. Steyn pers. obs.). Before being largely replaced by synthetic materials, kapok fibres were used for insulating and stuffing purposes (Kirby 1963). Kapok owes its use in e.g. life-saving equipment to the fact that the fibres remain buoyant after long periods in water (owing to its property of repelling water) and because it can easily be dried when it has become wet (Kirby 1963). According to Ilvessalo-Pfäffli (1995) the high buoyancy of kapok is due to the presence of air bubbles in the lumen of the fibres which apparently is also the case in *Salix* fibres.

#### *Dispersal by wind (anemochory)*

Confined to the rheophytic habitat, i.e. in the beds of swift-running rivers and streams and on the banks up to flood level (Jordaan 2002), *Salix mucronata* is exposed to up-and-down-stream breezes all the year round. When the capsules ripen and dehisce, the placental-funicular fibres dry out, break loose from the subepidermal tissue, expand and protrude from the bivalve fruit. During tests on dehiscent fruit, gusts of wind jerked the seed-bearing wool from the capsule, carrying it into the air and keeping fertile seeds airborne for about ten metres. At that distance the loose wool was blown apart, the hairy arils alone could not keep fertile seeds airborne and they descended. We propose that the same occurs in nature. Wind is therefore the releasing and the primary dispersal agent of *Salix* seed. It dislodges the seed from the capsule and scatters it some distance away from the parent plant. If the landing surface is not wet, the plumed seed may be blown further along the ground, but will stick to a wet substrate, e.g. mud, feathers or hair of wading birds and animals, bringing the role of wind to an end.

Characters enabling the seed to become airborne include its relative smallness, the absence of a large, heavy funicle and low specific weight. The latter is achieved by the thin, undifferentiated seed coat (testa) with air-filled

cells, an air space below the testa caused by the early disappearance of endosperm and enlargement of the seed surface by the long, smooth, air-filled hairs of the aril and seed-bearing wool.

#### *Dispersal by water (hydrochory)*

In its rheophytic habitat, the most important secondary dispersal agent for *Salix* seed is water. Our tests suggest that seed, landing in the bed of the stream or on the banks when the waters are in spate, will have the ability to float for days. In this way seeds may spread along the river edge far away from the parent plant or, caught in a strong current, they may migrate for many kilometres. Structural modifications for anemochory listed above, would increase buoyancy (Melcher *et al.* 2000). An additional adaptation for hydrochory in *Salix mucronata* is the unwettable seed surface. Van der Pijl (1969: 63) and Rauh *et al.* (1975: 372) reasoned that air bubbles, trapped in the numerous depressions in the seed coat epidermis, would have such an effect. In *Salix* this characteristic is aided by the presence of a unique floating apparatus in the form of a small (so as not to unduly increase seed weight), hilar aril with unwettable, air-filled hairs. The coma of hairs also ensures that the floating seed is not taken beyond the boundaries of the rheophytic habitat; when floodwaters recede, the fibres stick to wet mud, retaining the seed (Ridley 1930: 226). In these watery surroundings, the thin testa does not need to protect the embryo against desiccation and offers little resistance to germination. *Salix* seed germinates easily, seedlings have strong root systems and rapidly develop their first leaves (Pax 1894).

#### *Fortuitous dispersal by animals (epizoochory)*

Distribution of seed to upstream locations cannot occur by means of water and animal visitors to the water may play an important role here; *Salix* seeds have been removed from the coats of animals when the plants were in fruit (Ridley 1930: 554). It was found that the plumes attach themselves easily to the hair of animals when the vegetation is wet. The plumed seed may also become entangled in the feathers of waterfowl. To be carried in the mud on the feet of birds and animals, seeds have to be small and *Salix* seed certainly falls in this size group. While the plumes remain stuck in the mud, the small seeds may be picked up by the feet of waterfowl, hippopotamus, elephant and other animals and conveyed to another suitable rheophytic habitat.

#### *Taxonomic implications*

In a report on the phylogenetic relationships of *Salix* based on *rbcl* sequence data, Azuma *et al.* (2000: 71) stated that in their analysis '*Idesia* and *Dovyalis* of Flacourtiaceae are the sister groups of the Salicaceae'. Leskinen & Alström-Rapaport (1999) found that *Idesia polycarpa* Maxim. shows great sequence similarity with Salicaceae and that the 5.8S rDNA sequences in their study suggest that Flacourtiaceae and Salicaceae may have shared a common ancestor within the order Violales. Chase *et al.* (2002) provide evidence that if a wider range of flacourt genera is included in an analysis, *Itoa* Hemsl. and *Poliothlysis* Oliv. (Flacourtiaceae: Flacourtiaceae) seem to be the closest relatives of Salicaceae *s.str.*



As far as embryological data are concerned, Meeuse (1975) compared anther and ovule characters of Salicaceae *s.str.* and Flacourtiaceae *s.l.* and found 'many points of agreement' (Meeuse 1975: table 1). To these shared characters should be added the presence of arillate seeds. The presence of an aril on the seed of *Salix* offers some morphological support for combining on phylogenetic grounds Salicaceae *s.str.* with several flacourtiaceous taxa, members of which are reported to often have arillate seed (Chase *et al.* 2002). Several other authors who have previously suggested a close relationship between Salicaceae and some Flacourtiaceae are listed in Chase *et al.* (2002). However, if the putative close relationship between Salicaceae *s.str.* and Flacourtiaceae (Meeuse 1975; Chase *et al.* 1996; Nandi *et al.* 1998; Chase *et al.* 2002) is accepted, a radical change must have occurred during the evolution of the unitegmic, salicaceous seed with its undifferentiated seed coat. In Flacourtiaceae the seed coat develops from a bitegmic ovule and contains a fibrous exotegmen (Cormer 1976; Johri *et al.* 1992) that protects the zoochorous seed, often produced in edible berries (e.g. *Ilex*, *Flacourtia* L'Hér., *Dovyalis*) against animal feeders. No rheophytes have been reported in Flacourtiaceae (Van Steenis 1981) and anemochorous seed is extremely rare but may, according to Sleumer (1954) be granted to the winged seed of *Itoa*. *Poliothyrsis* also has winged seed (Judd *et al.* 2002). It is noteworthy that these two anemochorous genera are probably the sister groups of Salicaceae *s.str.* (Chase *et al.* 2002)—both are from China with *Itoa* also in tropical Asia. To our knowledge, their seed coat structure has not been reported.

#### CONCLUSION

We propose, therefore, that the total absence of an inner integument in *Salix* ovules and its suppression in early ovular stages in *Populus* (Nagaraj 1952) might be due to an adaptive change from animal to wind and water dispersal. This integument with its exotegmic protective layers was no longer necessary and would only increase seed weight. This could be another example of the well-known evolutionary tendency for unused structures, or unnecessary complication of structures, to degenerate (Cronquist 1988: 232). A study of ovule-to-seed development in *Dovyalis* is in progress and may shed more light on the possible evolutionary changes that have led to the Salicaceae *s.str.* clade.

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# Grass assemblages and diversity of conservation areas on the coastal plain south of Maputo Bay, Mozambique

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**Keywords:** dunes, forest, grasses, grassland, Maputaland, Mozambique, Poaceae, woodland

## ABSTRACT

A floristic analysis of the grass species assemblages of the Licuati Forest and Maputo Elephant Reserves south of Maputo Bay, Mozambique, is presented. Sampling of grass data was undertaken in six previously described, major vegetation types. TWINSpan divisions distinguished grass assemblages that are characteristic for these major vegetation types of the study area. The results were supported by an Indirect Gradient Analysis. Further TWINSpan divisions of a larger Maputaland data set indicated a floristic relationship between grass assemblages of similar major vegetation types in the study area and South Africa. This relationship was supported by high similarity values (> 65%), obtained with Sorensen's Coefficient. The coefficient also indicated varying degrees of similarity between grass assemblages of different major vegetation types within the study area. A rich diversity of 115 grass species and infraspecific taxa was recorded for the study area. The Chloridoideae and Panicoideae dominate the grass diversity and the genera with the most species include *Eragrostis*, *Panicum* and *Digitaria*. Most grass species in the study area are perennials and have a tufted growth form, but this varies considerably between vegetation types.

## INTRODUCTION

Despite the importance of the Poaceae to both subsistence and commercial agriculture (Myre 1971; Tainton *et al.* 1976) and the continued documentation of the rich diversity of this family in southern Africa (Gibbs Russell *et al.* 1990; Kobisi & Kose 2003), some areas still remain poorly studied and documented. One particular area is the coastal plain of Mozambique south of Maputo Bay. Although Myre (1964) and De Boer *et al.* (2000) provided a comprehensive account of the vegetation south of Maputo Bay in Mozambique, the descriptions of the grass layer contained limited taxonomic and floristic information.

In this paper the grass diversity of the coastal plain south of Maputo Bay is revisited to investigate the following hypotheses based on current knowledge: 1, different grass assemblages characterize the major vegetation types of the study area; 2, a floristic relationship exists between grass assemblages of different major vegetation types within the study area; 3, there is a floristic relationship between grass assemblages of the study area and similar vegetation types in South Africa; 4, species that form the grass assemblage for a major vegetation type are characterized by certain life/growth forms; 5, dominance of different Poaceae subfamilies in the study area correspond with predictions made previously; and 6, there is a rich diversity of grasses in the study area.

## STUDY AREA

The study area comprises the Maputo Elephant Reserve and Licuati Forest Reserve on the Maputaland coastal plain, south of Maputo Bay in Mozambique (Figure 1). Maputaland is an important centre of plant endemism and diversity of Mozambique, South Africa and Swaziland (Van Wyk & Smith 2001), defined as the biogeographical area bounded by the Inkomati-Limpopo River in the north, Indian Ocean in the east, foothills of the Lebombo Mountains in the west and St Lucia estuary in the south.

The topography comprises high, linear, north-south oriented dune cordons along the inland margin of the coast. The youngest of these dunes are probably 10 000–30 000 years old, making them in geological terms some of the youngest formations in southern Africa (Botha 1997). These high dune cordons mark a succession of marine regressions that deposited these sediments. Marine siltstone underlies these sediment deposits and in turn, the sediment deposits underlie the dune sand deposits currently defining the surface relief in this area.

Maputaland lies within a transitional zone between the tropics and subtropical coastal conditions to the south (Bruton & Cooper 1980), with warm to hot summers (mean of 27°C in January) and cool to warm winters with no frost (mean of 16°C in July). Mean relative air humidity is high along the coast, namely 55% in August and 90% in February. Summers are wetter than winters, although rain is received throughout the year. Mean annual rainfall is higher along the coast (1 100 mm/year) and declines progressively inland (600 mm/year). Morning mist is common in the dry season.

The study area comprises the major terrestrial vegetation types recognized and defined for this floristic region by Myre (1964), De Boer *et al.* (2000) and Matthews *et al.* (1999, 2001), namely Coastal Woodland, Dune Forest, Licuati (Sand) Forest, Primary Dunes, Reed Beds and Woody Grassland.

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FIGURE 1.—Locality of the Maputo Elephant and Licuati Forest Reserves in Mozambique and the Tembe Elephant Park and Sileza Nature Reserve in South Africa.

#### METHODS

Sampling sites were randomly selected using topographic maps and aerial photographs. Plots were placed in vegetation types conforming to the descriptions of Matthews *et al.* (1999, 2001), avoiding the edges of these and refraining from sampling in disturbed areas. Presence/absence of diagnostic woody species was used to identify vegetation types in the field. A vegetation type is a composition of species that recurs in a region as a result of specific combinations of environmental factors (Barbour *et al.* 1999). Reed Beds could not be sampled adequately due to high water tables. However, wetlands that feed into the Reed Beds were sampled, and these are referred to as Hygrophilous Grassland for the purpose of this study.

Twenty-one sites were sampled at the beginning of summer 2001, the peak flowering season for grasses. At each site all the grass species in a 20 × 20 m grid were collected and identified. Scientific names conform to Fish (2003). Voucher specimens are listed in a checklist (Appendix 1) and housed at the Maputo Herbarium (LMA), with duplicates in the Luanda Herbarium (LUA), Natal Herbarium (NH), Pretoria National Herbarium (PRE) and University of Zambia Herbarium (UZL). The LMA collection was consulted to identify sterile specimens and to locate fertile voucher specimens for these species. If none were found, sterile specimens were provisionally identified, but listed without voucher specimens in the checklist.

A floristic classification of grass data for the Licuati Forest and Maputo Elephant Reserves was obtained by the application of Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979a). The multivariate analysis divided the data set, comprising all collected grass species and their presence/absence data per plot, into nodes. In MEGATAB (Hennekens 1996) the resultant classification was summarized in a synoptic table to reflect percentage occurrence of each species per node (major vegetation type) and refined with Braun-Blanquet procedures to group species in assemblages. Detrended Correspondence Analysis (DECORANA) (Hill 1979b) was applied to the data set to illustrate vegetation gradients and floristic relationships.

A second data set containing grass species presence/absence data from the study area was merged with data from studies conducted in Sileza Nature Reserve (Matthews *et al.* 1999) and Tembe Elephant Park (Matthews *et al.* 2001). Vegetation types from these conservancies in South Africa were chosen for comparison because of their similar grass flora, status as pristine environments, proximity to the study area, and formal classification and description as representative of northern Maputaland. The TWINSPAN divisions depicting the floristic relationship are illustrated in a dendrogram (Figure 2).

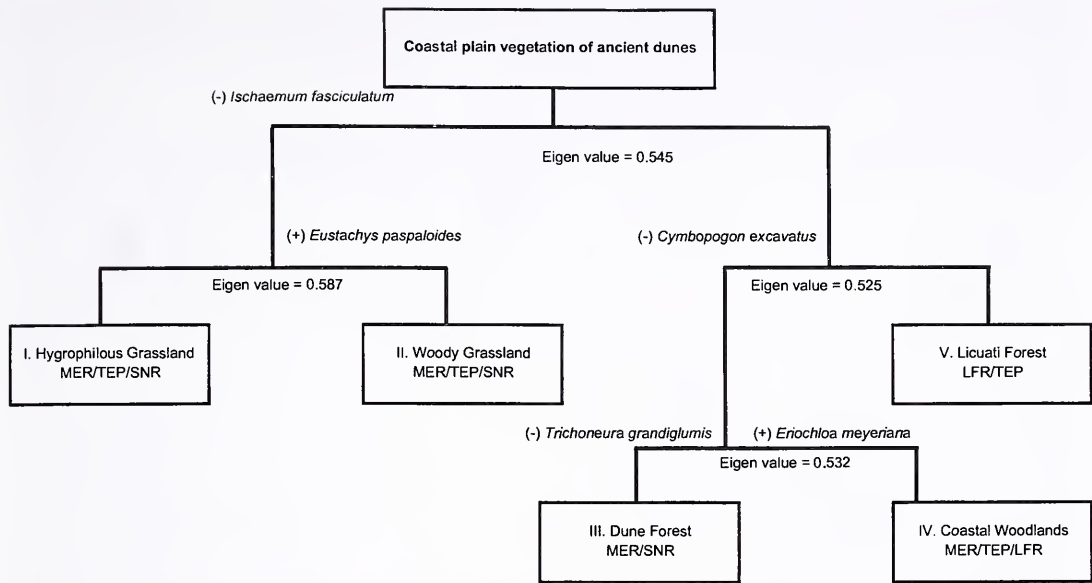


FIGURE 2.—Dendrogram of a TWINSpan division depicting the floristic relationships between the grass assemblages of the major vegetation types of four protected areas of the Maputaland coastal plain in Mozambique and South Africa. LFR, Licuati Forest Reserve; MER, Maputo Elephant Reserve; SNR, Sileza Nature Reserve; TEP, Tembe Elephant Park.

The species richness of grasses was calculated as the number of species per major vegetation type (homogeneous unit) in the study area (Whittaker 1978). Rare and threatened species were identified as either endemic (Van Wyk 1996) and/or Red Data List (Izidine & Bandeira 2002). Character species were defined as species that are relatively restricted to specific vegetation types (Westhoff & Van der Maarel 1978). Recognition as an introduced alien species was based on Fish (2003). Life cycles (annual or perennial) and growth form (tufted, rhizomatous and/or stoloniferous) of each species followed Gibbs Russell *et al.* (1990). Sorenson's Index (Mueller-Dombois & Ellenberg 1974) was used to determine the beta diversity between the vegetation types of the study area and between different reserves in Maputaland.

Floristic diversity of the Poaceae subfamilies/tribes, and the distribution of these taxonomic units within the different vegetation types were presented in tables to interpret and compare current patterns of grass diversity with what was previously predicted for southern Africa (Gibbs Russell 1986, 1988).

RESULTS AND DISCUSSION

The resultant hierarchical division of the sample plots from the TWINSpan analysis (Table 1) resulted in the classification of distinct grass assemblages associated with six major terrestrial vegetation types of the Maputaland coastal plain in Mozambique, namely Coastal Woodland, Dune Forest, Hygrophilous Grassland, Licuati Forest, Primary Dunes and Woody Grassland. The ordination clusters (Figure 3) obtained for the first and second axes tended to substantiate the groups identified in the TWINSpan classification. A TWINSpan division of the Mozambican grass data merged with sample plots from South Africa resulted in a hierarchy of assemblages that

confirms that a floristic link exists between these different parts of Maputaland (Figure 2).

Grass assemblages

1. Grass assemblage of Primary Dunes  
Locality: Maputo Elephant Reserve

This assemblage is restricted to the upper reaches of beaches, bordering on the seaward side of primary dunes. Grasses are mostly pioneers and are not only associated with the unstable seashore dunes, but also occur further inland along freshwater and saline marshes, and in disturbed places such as road reserves. Grasses of the assemblage prefer light shade, but tolerate full sun.

Character species for this grass assemblage are given in species group A (Table 1). The assemblage is species poor and although predominantly characterized by perennials, has the highest proportion of annuals (36%) in the study area. It also has the highest proportion of grass species with a stoloniferous growth form (35%). One naturalized alien grass, *Cenchrus brownii*, was recorded. Taxonomically the vegetation type is unique in that it is not characterized by the Paniceae (Panicoideae) as in the grass assemblages of the other vegetation types (Table 2), but is dominated by the Eragrostideae (Chloridoideae). The community is floristically most related to Hygrophilous Grassland (Sorenson Coefficient = 15%; Table 1) (Figure 3).

2. Grass assemblage of Hygrophilous Grassland  
Locality: Maputo Elephant Reserve

Hygrophilous Grassland represents a vegetation type of open grassland on seasonally wet, sandy or clay soils. These seasonally wet areas may occur as inter-dune

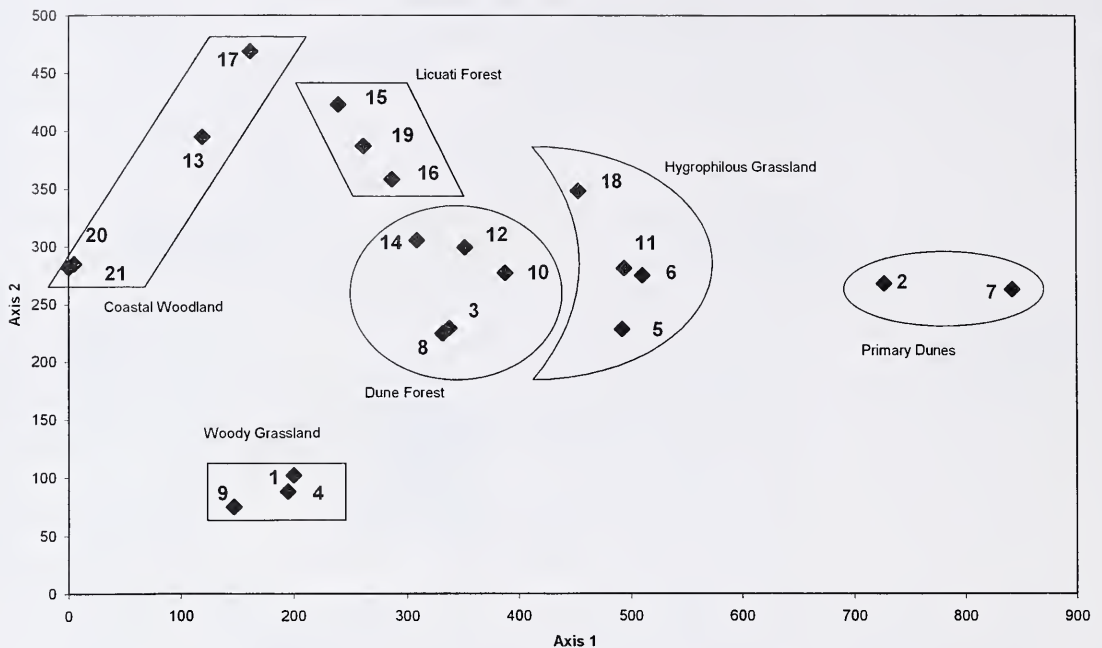


FIGURE 3.—Relative positions of sampling plots along the first and second ordination axes. Numbers refer to plots; polygons group the plots into grass assemblages.

depressions, pans, lake seepages, riverbanks and floodplains, and are characterized by high levels of organic matter and a water table of less than one metre below the soil surface. Soils are also less sandy and with a higher clay content. The biomass of the hygrophilous grass component is the highest due to dense growth under constant wet conditions.

Character species for the grass assemblage are given in species group B (Table 1). This grass assemblage is species rich (56 taxa) and tufted perennials dominate. It also has the highest proportion of rhizomatous taxa (36%). There are 15 character grass species, which is the most for any of the major vegetation types. This is the only grass assemblage in the study area characterized by representatives from the Arundineae, Aveneae and Oryzeae (Table 2). Floristically this assemblage is most related to Woody Grassland and Dune Forest (Sorenson Coefficient = 56% and 57% respectively; Table 1) (Figure 3). It also shows a high similarity in grass species composition when compared with plots from Maputaland Hygrophilous Grassland in South Africa (Sorenson Coefficient = 76%; Table 3) (Figure 2).

### 3. Grass assemblage of Woody Grassland

Locality: Maputo Elephant Reserve

Extensive grasslands occur along the coast south of Maputo Bay and is characterized by deep, well-drained sandy to loam soils and an undulating topography (dunes and floodplains). This grassland type is endemic to Maputaland and is dominated by geoxylic suffrutices which are dwarf woody plants with annual or short-lived shoots sprouting from woody, perennial underground axes. Woody Grassland is not as rich in grass species as the Hygrophilous Grassland.

Character species of the grass assemblage are given in species group D (Table 1). A low number of four character species were recorded, because grassland represents a transition between other major vegetation types. This assemblage is characterized by tufted, perennial species. The Andropogoneae (Panicoideae) dominate the assemblage (Table 2). One rare grass species, namely the Maputaland endemic *Trichoneura schlechteri*, was recorded. Floristically it is most related to Dune Forest, Coastal Woodland and Hygrophilous Grassland (Sorenson Coefficient = 62%, 58% and 56% respectively; Table 1) (Figure 3). Of all the grass assemblages in the study area, it has the lowest similarity in grass species composition when compared with similar vegetation further south in South Africa (Sorenson Coefficient = 63%; Table 3) (Figure 2).

### 4. Grass assemblage of Dune Forest

Locality: Maputo Elephant Reserve

Forests mainly occur on well-established secondary dunes and further inland. Soils are moist, deep and sandy. Forest trees have a higher diversity of creepers and understorey vegetation than the vegetation of surrounding areas. Grass species of Dune Forest prefer semi-shade and are especially common along forest margins, riverbanks, and partially disturbed and overgrazed areas.

Seven character species for this grass assemblage are given in species group F (Table 1). This grass assemblage is the most species rich (57 taxa). It is characterized by tufted perennials, has the highest number of recorded rare grass species (5) and taxonomically it is dominated by the Panicoideae, although the Eragrosti-deae, a tribe of the Chloridoideae, supports the highest diversity (Table 2). Along the coast, Dune Forest tends to



TABLE 1.—Diagnostic grass assemblages of the major vegetation types of the Maputaland coastal plain south of Maputo Bay in Mozambique. p, perennial; a, annual; s, stoloniferous; t, tufted; r, rhizomatous

| Nodum  | I   | II  | III | IV | V  | VI |
|--|-----|-----|-----|----|----|----|
| Vegetation type  | PD  | HG  | WG  | DF | CW | LF |
| Sample sites   | 2   | 4   | 3   | 5  | 4  | 3  |
| <b>Species Group A:</b> Diagnostic grass assemblage of Primary Dunes (PD)          |     |     |     |    |    |    |
| <i>Dactyloctenium australe</i> p s   | 100 | .   | .   | .  | .  | .  |
| <i>Digitaria ciliaris</i> a t  | 100 | .   | .   | .  | .  | .  |
| <i>Stenotaphrum dimidiatum</i> p s   | 100 | .   | .   | .  | .  | .  |
| * <i>Cenchrus brownii</i> a t  | 50  | .   | .   | .  | .  | .  |
| <i>Dactyloctenium aegyptium</i> a t s  | 50  | .   | .   | .  | .  | .  |
| <b>Species Group B:</b> Diagnostic grass assemblage of Hygrophilous Grassland (HG) |     |     |     |    |    |    |
| <i>Hemarthria altissima</i> p r s  | .   | 100 | .   | .  | .  | .  |
| <i>Acroceras macrum</i> p r t  | .   | 75  | .   | .  | .  | .  |
| <i>Andropogon eucomus</i> p t  | .   | 50  | .   | .  | .  | .  |
| <i>Leersia hexandra</i> p r  | .   | 50  | .   | .  | .  | .  |
| <i>Monocymbium ceresiiforme</i> p r t  | .   | 50  | .   | .  | .  | .  |
| <i>Andropogon huillensis</i> p t   | .   | 50  | .   | .  | .  | .  |
| <i>Echinochloa pyramidalis</i> p r s   | .   | 50  | .   | .  | .  | .  |
| <i>Panicum infestum</i> p r t  | .   | 50  | .   | .  | .  | .  |
| <i>Paspalum scrobiculatum</i> p r s  | .   | 50  | .   | .  | .  | .  |
| <i>Agrostis lachnantha</i> var. <i>lachnantha</i> p t                              | .   | 25  | .   | .  | .  | .  |
| <i>Brachiaria humidicola</i> p s   | .   | 25  | .   | .  | .  | .  |
| <i>Digitaria debilis</i> a t   | .   | 25  | .   | .  | .  | .  |
| <i>Digitaria gymnostachys</i> p t  | .   | 25  | .   | .  | .  | .  |
| <i>Phragmites australis</i> p r  | .   | 25  | .   | .  | .  | .  |
| <i>Phragmites mauritianus</i> p r  | .   | 25  | .   | .  | .  | .  |
| <b>Species Group C</b>   |     |     |     |    |    |    |
| <i>Sporobolus virginicus</i> p s r   | 50  | 50  | .   | .  | .  | .  |
| <i>Hyparrhenia dichroa</i> p r t   | 50  | 25  | .   | .  | .  | .  |
| <b>Species Group D:</b> Diagnostic grass assemblage of Woody Grassland (WG)        |     |     |     |    |    |    |
| <i>Eragrostis sclerantha</i> p t   | .   | .   | 70  | .  | .  | .  |
| <i>Heteropogon contortus</i> p r   | .   | .   | 30  | .  | .  | .  |
| <i>Hyparrhenia filipendula</i> var. <i>filipendula</i> p r t                       | .   | .   | 30  | .  | .  | .  |
| <i>Triraphis andropogonoides</i> p r   | .   | .   | 30  | .  | .  | .  |
| <b>Species Group E</b>   |     |     |     |    |    |    |
| <i>Eragrostis inanoena</i> p t r   | .   | 100 | 70  | .  | .  | .  |
| <i>Ischaemum fasciculatum</i> p r  | .   | 100 | 30  | .  | .  | .  |
| <i>Panicum genuflexum</i> p t  | .   | 75  | 30  | .  | .  | .  |
| <i>Sorghastrum stipoides</i> p t   | .   | 75  | 30  | .  | .  | .  |
| <i>Eragrostis capensis</i> p t   | .   | 50  | 30  | .  | .  | .  |
| <i>Echinochloa colona</i> a s t  | .   | 25  | 30  | .  | .  | .  |
| <b>Species Group F:</b> Diagnostic grass assemblage of Dune Forest (DF)            |     |     |     |    |    |    |
| <i>Digitaria argyrothricha</i> p t r   | .   | .   | .   | 80 | .  | .  |
| ** <i>Panicum pleianthum</i> p t   | .   | .   | .   | 60 | .  | .  |
| <i>Triraphis schinzii</i> p r t  | .   | .   | .   | 60 | .  | .  |
| <i>Setaria megaphylla</i> p r t  | .   | .   | .   | 40 | .  | .  |
| <i>Bothriochloa insculpta</i> p s  | .   | .   | .   | 20 | .  | .  |
| <i>Brachiaria deflexa</i> a t  | .   | .   | .   | 20 | .  | .  |
| ** <i>Brachychloa schiemaniana</i> p s   | .   | .   | .   | 20 | .  | .  |
| <b>Species Group G</b>   |     |     |     |    |    |    |
| <i>Cynodon dactylon</i> p r s  | 100 | 75  | .   | 20 | .  | .  |
| <i>Dactyloctenium geminatum</i> p r s  | 50  | 75  | .   | 60 | .  | .  |
| <i>Sporobolus africanus</i> p r t  | 50  | 50  | .   | 20 | .  | .  |
| <b>Species Group H</b>   |     |     |     |    |    |    |
| <i>Imperata cylindrica</i> p r   | .   | 75  | .   | 20 | .  | .  |
| <i>Eragrostis ciliaris</i> a t   | .   | 50  | .   | 20 | .  | .  |
| <i>Brachiaria nigropedata</i> p t r  | .   | 25  | .   | 20 | .  | .  |
| <i>Dactyloctenium giganteum</i> a t  | .   | 25  | .   | 20 | .  | .  |
| <i>Dinebra retroflexa</i> var. <i>condensata</i> a t                               | .   | 25  | .   | 20 | .  | .  |
| <i>Eragrostis species</i> p t  | .   | 25  | .   | 20 | .  | .  |
| <b>Species Group I</b>   |     |     |     |    |    |    |
| <i>Eragrostis lappula</i> p r t  | .   | 100 | 70  | 80 | .  | .  |
| <i>Sporobolus subtilis</i> p r t   | .   | 75  | 30  | 60 | .  | .  |
| <i>Aristida congesta</i> subsp. <i>barbicollis</i> p t                             | .   | 50  | 30  | 20 | .  | .  |
| <i>Elionurus muticus</i> p t   | .   | 50  | 70  | 40 | .  | .  |
| <i>Digitaria natalensis</i> p t r  | .   | 25  | 70  | 60 | .  | .  |
| <i>Sporobolus subulatus</i> p t r  | .   | 25  | 30  | 20 | .  | .  |
| <b>Species Group J:</b> Diagnostic grass assemblage of Coastal Woodland (CW)       |     |     |     |    |    |    |
| * <i>Coix lacryma-jobi</i> a t   | .   | .   | .   | .  | 25 | .  |
| <i>Cenchrus ciliaris</i> p t   | .   | .   | .   | .  | 25 | .  |
| <i>Chloris virgata</i> a t   | .   | .   | .   | .  | 25 | .  |
| <i>Enneapogon scoparius</i> p t  | .   | .   | .   | .  | 25 | .  |
| <i>Eragrostis sarmentosa</i> p r t   | .   | .   | .   | .  | 25 | .  |

TABLE 1.—Diagnostic grass assemblages of the major vegetation types of the Maputaland coastal plain south of Maputo Bay in Mozambique. p, perennial; a, annual; s, stoloniferous; t, tufted; r, rhizomatous (cont.)

| Nodum  | I            | II           | III         | IV           | V           | VI          |
|--|--------------|--------------|-------------|--------------|-------------|-------------|
| Vegetation type  | PD           | HG           | WG          | DF           | CW          | LF          |
| Sample sites   | 2            | 4            | 3           | 5            | 4           | 3           |
| <b>Species Group J (cont.)</b>   |              |              |             |              |             |             |
| <i>Eriochloa meyeriana</i> subsp. <i>meyeriana</i> p t                     | .            | .            | .           | .            | 25          | .           |
| <i>Panicum coloratum</i> var. <i>coloratum</i> p t                         | .            | .            | .           | .            | 25          | .           |
| <i>Setaria incrassata</i> p r t  | .            | .            | .           | .            | 25          | .           |
| <i>Sorghum bicolor</i> subsp. <i>arundinaceum</i> p t                      | .            | .            | .           | .            | 25          | .           |
| <b>Species Group K</b>   |              |              |             |              |             |             |
| <i>Trichoneura grandiglumis</i> p t  | .            | .            | 100         | 40           | 50          | .           |
| <i>Eustachys paspaloides</i> p r t   | .            | .            | 70          | 80           | 75          | .           |
| <i>Sporobolus sanguineus</i> p t r   | .            | .            | 70          | 40           | 25          | .           |
| <i>Andropogon schirensis</i> p t   | .            | .            | 30          | 40           | 25          | .           |
| <i>Cymbopogon excavatus</i> p t  | .            | .            | 30          | 80           | 25          | .           |
| <i>Cymbopogon nardus</i> p t   | .            | .            | 30          | 60           | 75          | .           |
| <i>Melinis repens</i> subsp. <i>repens</i> a t                             | .            | .            | 30          | 20           | 25          | .           |
| <b>Species Group L</b>   |              |              |             |              |             |             |
| <i>Eragrostis heteromera</i> p t   | .            | 75           | .           | 40           | 25          | .           |
| <i>Diheteropogon amplexens</i> p r   | .            | 75           | 100         | 40           | 100         | .           |
| <i>Themeda triandra</i> p t r  | .            | 50           | 100         | 20           | 75          | .           |
| <i>Setaria sphacelata</i> var. <i>sericea</i> p r t                        | .            | 50           | 70          | 20           | 50          | .           |
| <i>Bewisia biflora</i> p r t   | .            | 50           | 30          | 40           | 25          | .           |
| <i>Pogonarthria squarrosa</i> p t r  | .            | 25           | 100         | 40           | 50          | .           |
| <i>Trachypogon spicatus</i> p r t  | .            | 25           | 70          | 40           | 75          | .           |
| <i>Sacciolepis curvata</i> p t r   | .            | 25           | 70          | 40           | 100         | .           |
| <i>Urelytrum agropyroides</i> p t  | .            | 25           | 30          | 20           | 50          | .           |
| <i>Urochloa mosambicensis</i> p s t  | .            | 25           | 30          | 20           | 50          | .           |
| <i>Hyperthelia dissoluta</i> p t   | .            | 25           | 30          | 20           | 25          | .           |
| <i>Andropogon gayanus</i> var. <i>polycladus</i> p t                       | .            | 25           | .           | 60           | 25          | .           |
| <i>Chloris gayana</i> p s t  | .            | 25           | .           | .            | 25          | .           |
| <b>Species Group M: Diagnostic grass assemblage of Licuati Forest (LF)</b> |              |              |             |              |             |             |
| <i>Megastachya mucronata</i> p s   | .            | .            | .           | .            | .           | 70          |
| <i>Digitaria longiflora</i> p s t  | .            | .            | .           | .            | .           | 30          |
| <i>Elrharta erecta</i> var. <i>natalensis</i> p t                          | .            | .            | .           | .            | .           | 30          |
| <i>Eragrostis gummiflua</i> p t  | .            | .            | .           | .            | .           | 30          |
| <i>Oplismenus hirtellus</i> p t  | .            | .            | .           | .            | .           | 30          |
| <i>Tristachya nodighonis</i> p t   | .            | .            | .           | .            | .           | 30          |
| <i>Melinis repens</i> subsp. <i>grandiflora</i> a t                        | .            | .            | .           | .            | .           | 30          |
| <b>Species Group N</b>   |              |              |             |              |             |             |
| <i>Eragrostis superba</i> p t  | .            | .            | .           | .            | 75          | 30          |
| <i>Eragrostis pallens</i> p t  | .            | .            | .           | .            | 25          | 30          |
| <b>Species Group O</b>   |              |              |             |              |             |             |
| <i>Panicum deustum</i> p r t   | .            | .            | .           | 80           | 50          | 100         |
| <i>Sporobolus fimbriatus</i> p t r   | .            | .            | .           | 80           | 50          | 30          |
| <i>Brachiaria chusqueoides</i> a t   | .            | .            | .           | 80           | .           | 70          |
| ** <i>Eragrostis moggii</i> var. <i>moggii</i> p t s                       | .            | .            | .           | 80           | .           | 30          |
| <i>Panicum heterostachyum</i> a t  | .            | .            | .           | 40           | 25          | 30          |
| ** <i>Alloteropsis papillosa</i> p t                                       | .            | .            | .           | 20           | 50          | 70          |
| <i>Panicum laticomum</i> a t s   | .            | .            | .           | 20           | 25          | 100         |
| <i>Eleusine coracana</i> subsp. <i>africana</i> a t                        | 50           | .            | .           | 20           | .           | 30          |
| <i>Eleusine indica</i> a s t   | .            | .            | .           | 20           | .           | 30          |
| <b>Species Group P</b>   |              |              |             |              |             |             |
| <i>Aristida stipitata</i> subsp. <i>graciliflora</i> p t                   | .            | .            | 100         | 80           | 75          | 70          |
| ** <i>Trichoneura schlechteri</i> p t                                      | .            | .            | 30          | 20           | 25          | 30          |
| <b>Species Group Q</b>   |              |              |             |              |             |             |
| <i>Panicum maximum</i> p t   | .            | 50           | 70          | 80           | 100         | 30          |
| <i>Aristida congesta</i> subsp. <i>congesta</i> p t                        | .            | 50           | 30          | 20           | 25          | 30          |
| <i>Perotis patens</i> p t  | .            | 50           | 100         | 40           | 100         | 30          |
| <i>Digitaria eriantha</i> p s t  | .            | 25           | 70          | 20           | 100         | 30          |
| <i>Panicum kalaharens</i> p r t  | .            | 25           | 30          | 40           | 25          | 30          |
| Percentage perennial/annual  | 64 / 36      | 91 / 9       | 95 / 5      | 82 / 18      | 88 / 12     | 76 / 24     |
| Percentage tufted/rhizomatous/stoloniferous                                | 35 / 30 / 35 | 51 / 36 / 13 | 63 / 32 / 5 | 60 / 29 / 11 | 70 / 23 / 7 | 73 / 9 / 18 |
| Total no. species  | 11           | 56           | 40          | 57           | 43          | 25          |
| Restricted to community (character species)                                | 6            | 15           | 4           | 7            | 9           | 7           |
| *No. naturalized aliens  | 3            | 0            | 0           | 0            | 1           | 0           |
| **No. rare and threatened species  | 0            | 0            | 1           | 5            | 2           | 3           |
| <b>Sorensen Coefficient (%):</b>   |              |              |             |              |             |             |
| PD   | 100          | 15           | 0           | 9            | 0           | 0           |
| HG   | 15           | 100          | 56          | 57           | 36          | 12          |
| WG   | 0            | 56           | 100         | 62           | 58          | 22          |
| DF   | 9            | 57           | 62          | 100          | 62          | 39          |
| CW   | 0            | 36           | 58          | 62           | 100         | 41          |
| LF   | 0            | 12           | 22          | 39           | 41          | 100         |

TABLE 2.—Numbers of species of Poaceae subfamilies/tribes recorded within major vegetation types of Maputaland, south of Maputo Bay

| Subfamily/Tribe | Vegetation types* |    |    |    |    |    |
|-----------------|-------------------|----|----|----|----|----|
|                 | PD                | HG | WG | DF | CW | LF |
| Bambusoideae    | 0                 | 1  | 0  | 0  | 0  | 1  |
| Oryzeae         | -                 | 1  | -  | -  | -  | -  |
| Ehrharteae      | -                 | -  | -  | -  | -  | 1  |
| Pooideae        | 0                 | 1  | 0  | 0  | 0  | 0  |
| Aveneae         | -                 | 1  | -  | -  | -  | -  |
| Centothecoideae | 0                 | 0  | 0  | 0  | 0  | 1  |
| Centothecaeae   | -                 | -  | -  | -  | -  | 1  |
| Arundinoideae   | 0                 | 4  | 3  | 3  | 2  | 2  |
| Arundineae      | -                 | 2  | -  | -  | -  | -  |
| Aristideae      | -                 | 2  | 3  | 3  | 2  | 2  |
| Chloridoideae   | 7                 | 18 | 14 | 24 | 15 | 9  |
| Pappophoreae    | -                 | -  | -  | -  | 1  | -  |
| Eragrostideae   | 6                 | 15 | 12 | 21 | 10 | 8  |
| Cynodonteae     | 1                 | 3  | 2  | 3  | 4  | 1  |
| Panicoideae     | 4                 | 32 | 23 | 30 | 26 | 12 |
| Paniceae        | 3                 | 17 | 10 | 18 | 15 | 11 |
| Arundinelleae   | -                 | -  | -  | -  | -  | 1  |
| Andropogoneae   | 1                 | 15 | 13 | 12 | 11 | -  |
| TOTAL           | 11                | 56 | 40 | 57 | 43 | 25 |

\* CW, Coastal Woodland; DF, Dune Forest; HG, Hygrophilous Grassland; LF, Licuati Forest; PD, Primary Dunes; WG, Woody Grassland

be continuous, but inland it forms a mosaic with other vegetation types. Its grass assemblage therefore shows a strong floristic link with Woody Grassland, Coastal Woodland, Hygrophilous Grassland, and to a lesser extent Licuati Forest (Sorenson Coefficient = 62%, 62%, 57% and 39% respectively; Table 1) (Figure 3). It also shows a high similarity in grass species composition when compared with plots from Maputaland Dune Forest in South Africa (Sorenson Coefficient = 71%; Table 3) (Figure 2).

5. Grass assemblage of Coastal Woodland  
Locality: Maputo Elephant Reserve and Licuati Forest Reserve

Savanna covers extensive areas along the coast south of Maputo Bay and stretches westwards to the foothills of the Lebombo Mountains. The vegetation type occurs on sandy soils in drier habitats with a deeper water table. The grass assemblage forms a dense herbaceous layer and is associated with light shade or full sunlight and

occurs in a wide range of habitats including floodplains, dune crests, drainage lines, transition zones and disturbed areas.

Nine character species were recorded for this assemblage and are given in species group J (Table 1). Tufted perennials typically dominate this grass assemblage. Two rare species were recorded and one naturalized alien grass, *Coix lacryma-jobi*, has colonized this assemblage. This is the only grass assemblage that contains a member of the Pappophoreae and is dominated by the Panicoideae (Table 2). Dune Forest forms localized patches within Coastal Woodland, and in turn, Coastal Woodland within Woody Grassland. Hence, its grass assemblage shows a strong floristic link with Dune Forest and Woody Grassland, and to a lesser extent with Licuati Forest on which it borders (Sorenson Coefficient = 62%, 58% and 41% respectively; Table 1) (Figure 3). The assemblage is similar to that of corresponding Maputaland woodlands in South Africa (Sorenson Coefficient = 67%; Table 3) (Figure 2).

6. Grass assemblage of Licuati Forest  
Locality: Licuati Forest Reserve

This vegetation type is endemic to Maputaland and has many rare plant species. It is restricted to the ancient coastal dunes of Maputaland, and drier (600 mm per annum) conditions than most of the other coastal forest types in southern Africa. This grass assemblage prefers moister habitats in shady places and is common along forest margins. Based on vegetation structure and species composition the forests of ancient dunes in Maputaland can be divided into Licuati Forest and Licuati Thicket (Izidine *et al.* 2003).

Character species of the grass assemblage are given in species group M (Table 1). Although it is a forest system and tufted perennials dominate the grass assemblage, this vegetation type has a high proportion (24%) of annual species. The assemblage is species poor, but a high proportion of three rare species are recorded for the assemblage. This is the only vegetation type in the study area with representatives from the Arundinelleae, Centothecaeae and Ehrharteae, and the only one without a representative of the Andropogoneae (Table 2). This grass assemblage is related to Coastal Woodland and Dune Forest as a result of similar microhabitats (Sorenson Coefficient = 41% and 39% respectively; Table 1) (Figure 3). It also shows a high similarity in grass species composition when compared with plots from Maputaland sand forest in South Africa (Sorenson Coefficient = 71%; Table 3) (Figure 2).

Floristic analysis

In a provisional checklist compiled from available literature for the two Maputaland reserves in Mozambique, the Poaceae numbered 52 species/infraspecific taxa and 36 genera. Currently, with 95% of the collected specimens identified, the updated checklist (Appendix 1) contains 115 species/infraspecific taxa and 56 genera. However, 15 species previously recorded were not collected again. Most of these taxa are either locally rare (e.g. *Panicum genuflexum* and *Triraphis andropogonoides*) or wetland species (e.g. *Leersia hexandra* and

TABLE 3.—Similarity indices of grass assemblages shared between major Maputaland vegetation types in Mozambique (Moz) and South Africa (RSA)

| Vegetation type* | Total species (Moz) | Total species (RSA) | Shared between Moz and RSA | Sorenson Index (Ss)% |
|------------------|---------------------|---------------------|----------------------------|----------------------|
| HG               | 37                  | 37                  | 28                         | 76                   |
| WG               | 22                  | 32                  | 17                         | 63                   |
| DF               | 42                  | 34                  | 26                         | 71                   |
| CW               | 31                  | 32                  | 21                         | 67                   |
| LF               | 26                  | 19                  | 16                         | 71                   |

\* CW, Coastal Woodland; DF, Dune Forest; HG, Hygrophilous Grassland; LF, Licuati Forest; WG, Woody Grassland



TABLE 4.—Floristic analysis of subfamilies and tribes recorded for Maputo Elephant and Licuati Forest Reserves

| Tribe/Subfamily         | Major associated vegetation types* | Rare species | Alien species | Tribes   | Genera    | Species   | Species/infraspecific taxa | Percentage of subfamily |
|-------------------------|------------------------------------|--------------|---------------|----------|-----------|-----------|----------------------------|-------------------------|
| Oryzaceae               | HG                                 | -            | -             | -        | 1         | 1         | 1                          | -                       |
| Ehrharteae              | LF                                 | -            | -             | -        | 1         | 1         | 1                          | -                       |
| <b>Bambusoideae</b>     | <b>LF, HG</b>                      | <b>0</b>     | <b>0</b>      | <b>2</b> | <b>2</b>  | <b>2</b>  | <b>2</b>                   | <b>15%</b>              |
| Aveneae                 | HG                                 | -            | -             | -        | 1         | 1         | 1                          | -                       |
| Pooideae                | HG                                 | 0            | 0             | 1        | 1         | 1         | 1                          | 1%                      |
| Centotheceae            | LF                                 | -            | -             | -        | 1         | 1         | 1                          | -                       |
| <b>Centothechoideae</b> | <b>LF</b>                          | <b>0</b>     | <b>0</b>      | <b>1</b> | <b>1</b>  | <b>1</b>  | <b>1</b>                   | <b>?</b>                |
| Arundineae              | HG                                 | -            | -             | -        | 1         | 2         | 2                          | -                       |
| Aristideae              | DF, LF                             | -            | -             | -        | 1         | 2         | 4                          | -                       |
| <b>Arundinoideae</b>    | <b>DF, LF</b>                      | <b>0</b>     | <b>0</b>      | <b>2</b> | <b>2</b>  | <b>4</b>  | <b>6</b>                   | <b>2%</b>               |
| Pappophoreae            | CW                                 | -            | -             | -        | 1         | 2         | 2                          | -                       |
| Eragrostideae           | DF, HG                             | 3            | -             | -        | 10        | 32        | 32                         | -                       |
| Cynodonteae             | CW, DF                             | -            | -             | -        | 4         | 5         | 5                          | -                       |
| <b>Chloridoideae</b>    | <b>DF, CW, HG</b>                  | <b>3</b>     | <b>0</b>      | <b>3</b> | <b>15</b> | <b>39</b> | <b>39</b>                  | <b>17%</b>              |
| Paniceae                | DF, HG, LF                         | 2            | 2             | -        | 16        | 40        | 41                         | -                       |
| Arundinelleae           | LF                                 | -            | -             | -        | 1         | 1         | 1                          | -                       |
| Andropogoneae           | HG, WG, DF                         | -            | 1             | -        | 18        | 24        | 24                         | -                       |
| <b>Panicoideae</b>      | <b>DF, HG</b>                      | <b>2</b>     | <b>3</b>      | <b>3</b> | <b>35</b> | <b>65</b> | <b>66</b>                  | <b>19%</b>              |
| TOTAL                   |                                    | 5            | 3             | 12       | 56        | 112       | 115                        |                         |

\*CW, Coastal Woodland; DF, Dune Forest; HG, Hygrophilous Grassland; LF, Licuati Forest; WG, Woody Grassland

*Dinebra retroflexa* var. *condensata*), for which high water tables made their localized habitats inaccessible.

In the study area the most commonly represented subfamilies are the Panicoideae with 66 species/infraspecific taxa (accounting for 57% of the total checklist) and Chloridoideae with 39 taxa (34%) (Table 4). Together they account for 91% of the species in the checklist. The tribes with the most species are the Paniceae (41 taxa), Eragrostideae (32 taxa) and Andropogoneae (24 taxa) (Table 4). The genera with the most species are *Eragrostis* (12), *Panicum* (10), *Digitaria* (8) and *Sporobolus* (6). *Andropogon*, *Brachiaria* and *Dactyloctenium* are represented by four species each.

Interesting species were recorded, such as *Panicum kalaharensis* (usually associated with much drier areas on Kalahari sands) and *Monocymbium cerasiiforme* (usually associated with much higher altitudes on mountains). Many grass species of direct significance for conservation initiatives, reserve management and sustainable utilization were also recorded:

1, three Maputaland endemic grasses belonging to the Eragrostidae (Van Wyk 1996). *Brachychloa schiemaniana* occurs in Dune Forest, *Eragrostis moggii* var. *moggii* is associated with Licuati Forest and Dune Forest, and *Trichoneura schlechteri* is found in Coastal Woodlands, Dune Forest, Licuati Forest and Woody Grassland. *Brachychloa fragilis* was not recorded, although it is a typical endemic associated with deep sands in South Africa;

2, three alien grasses belonging to the Panicoideae. As is the case in many Centres of Endemism in the world (Stohlgren *et al.* 1999), alien taxa have also invaded Maputaland. *Cenchrus brownii* has invaded vegetation of Primary Dunes and *Coix lacryma-jobi* and *Digitaria didactyla* occurs in Coastal Woodland in the vicinity of villages;

3, two Red Data List grass species: *Panicum pleianthum* from Dune Forest which is assessed as Low Risk (Izidine & Bandeira 2002), and *Alloteropsis papillosa* from Dune Forest, Coastal Woodland and Licuati Forest which is assessed as Insufficiently Known (Hilton-

Taylor 1996). Both species are locally common and known to occur as far north as Kenya and Tanzania;

4, eight grasses that are important for rural livelihoods. Some species are used as important components to build huts: *Phragmites australis* for the walls and *Cymbopogon excavatus*, *Imperata cylindrica* and *Hyperthelia dissoluta* to thatch the roof (Mangue 1999). *Dactyloctenium giganteum*, *Eleusine coracana* subsp. *africana*, *Echinochloa pyramidalis* and *Sorghum bicolor* subsp. *arundinaceum* are used as indigenous grass cereals (Scudder 1971).

Correlation analyses of the floristic data did not reveal any meaningful relationships. The only significant positive correlation ( $n = 6$ ;  $r = 0.827$ ;  $P = 0.04$ ) was obtained between the number of rare/endemic grass species and the number of annual grass species per vegetation type. Forests/woodlands have higher numbers of rare/endemic and annual grass species than grasslands.

### Distribution patterns

All known distributions of the six grass subfamilies extend into southern Mozambique. The diversity of the Chloridoideae and the Panicoideae in the study area was expected and subsequently were the best represented in the major vegetation types. The dominance of the Panicoideae (both  $C_3$  and  $C_4$  grasses) in the terrestrial vegetation types coincides with the centre of diversity of the subfamily in mesic summer rainfall regions (Gibbs Russell 1986). However, its diversity was much lower than would be expected (19% instead of the predicted 46–60%) (Table 4). The diversity of species of the Chloridoideae (mainly  $C_4$  aspartate producers) was within the expected range of 16–30% (17% of the subfamily's species was recorded) (Table 4), as this subfamily's centre of diversity is mainly situated further north in arid summer rainfall regions (Gibbs Russell 1986). Chloridoideae dominated the grass assemblage of the Primary Dunes. The species diversity of the other four subfamilies was as predicted by Gibbs Russell (1988). Arundi-

noideae is dominant in Hygrophilous Grassland and the remaining three subfamilies are associated mainly with Hygrophilous Grassland and Licuati Forest.

The tribes, Eragrostideae (C<sub>4</sub> aspartate), Paniceae (both C<sub>3</sub> and C<sub>4</sub>) and Andropogoneae (C<sub>4</sub> malate) dominate the grass assemblages of the major vegetation types, probably due to specific regional climatic conditions, such as high temperatures at the local scale, which favour these C<sub>4</sub> groups to successfully colonize specific habitats. Eragrostideae dominate the grass assemblages of Dune Forest and Primary Dunes, the Paniceae dominate in Coastal Woodland, Hygrophilous Grassland and Licuati Forest, and the Andropogoneae in Woody Grassland (Table 2). The Aristideae and Cynodonteae are found in nearly all the vegetation types, but are restricted to a maximum of four species per vegetation type. This is low when compared to the maximum of 21, 18 and 15 species respectively recorded for the three dominant tribes. The remaining seven tribes are restricted to single vegetation types. Three of these tribes are associated with Licuati Forest, two with Hygrophilous Grassland and one with Coastal Woodland.

#### CONCLUSIONS

It is evident from the analysis of the grass diversity on the coastal plain of southern Mozambique that a specific grass flora is present and that six species assemblages are associated with and characteristic of certain major vegetation types of the coastal plain.

The grass assemblage of Dune Forest was qualitatively the most similar and central to the grass assemblages of the other vegetation types south of Maputo Bay. Primary Dunes have the most floristically unrelated grass assemblage to other vegetation types.

Similarity in grass assemblage composition was more than 60% for each vegetation type shared between reserves in Mozambique and South Africa. This relationship with areas further south links the grass assemblages to the Maputaland floristic region.

Grasses of the study area are mostly perennial. Woody Grassland has the highest proportion of perennial species and Primary Dunes the highest proportion of annuals. Tufted grasses are the most common growth form with the highest proportions in Licuati Forest and Coastal Woodland.

Chloridoideae and Panicoideae dominate the grass composition in the study area. The tribes Paniceae, Eragrostideae and Andropogoneae are represented most and *Eragrostis*, *Panicum* and *Digitaria* are the largest genera of this part of Maputaland.

The coastal plain south of Maputo Bay has a grass diversity of 115 species and infraspecific taxa. Dune Forest and Hygrophilous Grassland have the richest grass diversity. Dune Forest has the most rare and endemic grass species and Hygrophilous Grassland the most character species.

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## APPENDIX 1.—Checklist of grasses recorded for the major vegetation types of the Maputo Elephant and Licuati Forest Reserves

Arrangement and classification follow Clayton & Renvoize (1986) and author citations follow Brummitt & Powell (1992). Species names follow Fish (2003) and general practice at Maputo Herbarium (LMA). All specimens are housed at LMA, with duplicates specified for the herbaria of Luanda (LUA), Natal (NH), Pretoria (PRE) and University of Zambia (UZL). Naturalized alien species are marked with an asterisk\*, Maputaland endemic species with \*\*, and Red Data List species with \*\*\*. Abbreviations for collectors' names: *B*, Balsinhas; *DHN*, De Koning, Hiemstra & Nuvunga; *G*, Greenwood; *H*, Hornby; *Ma*, Martins; *MB*, Myre & Balsinhas; *MC*, Myre & Carvalho; *MD*, Myre & Duarte; *My*, Myre; *N*, Nyirenda; *P*, Pedro; *PP*, Pedro & Pedrogao; *S*, Siebert; *U*, Uiras; *V*, Viana; *Z*, field observations of sterile specimens.

### BAMBUSOIDEAE

#### ORYZEA

*Leersia hexandra* Sw., *Z* 14

#### EHRHARTEAE

*Ehrharta erecta* Lam. var. *natalensis* Stapf, *Z* 1

### POOIDEAE

#### AVENEAE

*Agrostis lachnantha* Nees var. *lachnantha*, *Ma* 101 (LUA), *H* 133

### CENTOTHECOIDEAE

#### CENTOTHECEAE

*Megastachya mucronata* (Poir.) P.Beauv., *S* 2180 (PRE), *U* 99 (NH)

### ARUNDINOIDEAE

#### ARUNDINEAE

##### Phragmites

*australis* (Cav.) Steud., *H* 123

*mauritanicus* Kunth, *DHN* 8846

#### ARISTIDEAE

*Aristida congesta* Roem. & Schult.

subsp. *barbicollis* (Trin. & Rupr.) De Winter, *S* 2137 (PRE), *U* 65 (NH)

subsp. *congesta*, *P* 3933

*Aristida stipitata* Hack.

subsp. *graciliflora* (Pilg.) Melderis, *S* 2161 (PRE), *U* 106 (NH)

subsp. *ramifera* (Pilg.) Melderis, *S* 2188 (PRE)

### CHLORIDOIDEAE

#### PAPPOPHOREAE

##### Enneapogon

*cenchröides* (Roem. & Schult.) C.E.Hubb., *MB* 349

*scoparius* Stapf, *Z* 2

#### ERAGROSTIDEAE

*Bewisia biflora* (Hack.) Gooss., *S* 2128 (PRE), *N* 506 (UZL)

\*\**Brachychloa schiemaniana* (Schweick.) S.M.Phillips, *S* 2141 (PRE), *U* 60 (NH)

##### Dactyloctenium

*aegyptium* (L.) Willd., *N* 350 (UZL)

*australe* Steud., *My* 3743

*geminatum* Hack., *S* 2158 (PRE), *U* 79 (NH)

*giganteum* Fisher & Schweick., *U* 94 (NH)

*Dinebra retroflexa* (Vahl) Panz. var. *condensata* S.M.Phillips, *Z* 3

##### Eleusine

*coracana* (L.) Gaertn. subsp. *africana* (Kenn.-O'Byrne) Hiu & De Wet, *S* 2130 (PRE)

*indica* (L.) Gaertn., *U* 98 (PRE)

##### Eragrostis

*capensis* (Thunb.) Trin., *S* 2122 (PRE), *U* 20 (NH)

*ciliaris* (L.) R.Br., *S* 2189 (PRE), *U* 27 (NH)

*gummiflua* Nees, *U* 104 (NH)

*heteromera* Stapf, *S* 2185 (PRE), *U* 97 (NH)

*inamoena* K.Schum., *S* 2125 (PRE)

*lappula* Nees, *S* 2144 (PRE), *U* 58 (NH)

\*\**moggii* De Winter var. *moggii*, *S* 2151 (PRE), *N* 372 (UZL)

*pallens* Hack., *S* 2174 (PRE), *U* 85 (NH)

*sarmentosa* (Thunb.) Trin., *S* 2164 (PRE)

*sclerantha* Nees subsp. *sclerantha*, *Z* 13

sp., *U* 61 (NH)

*superba* Peyr., *N* 362 (UZL), *U* 101 (NH)

*Pogonarthra squarrosa* (Roem. & Schult.) Pilg., *S* 2173 (PRE), *U* 53 (NH)

##### Sporobolus

*africanus* (Poir.) Robyns & Tournay, *S* 2140 (PRE), *U* 63 (NH)

*fimbriatus* (Trin.) Nees, *S* 2176 (PRE), *U* 89 (NH)

*sanguineus* Rendle, *S* 2186 (PRE), *U* 100 (NH)

*subtilis* Kunth, *N* 354 (UZL), *U* 81 (NH)

*subulatus* Hack., *S* 2123 (PRE)

*virginicus* (L.) Kunth, *S* 2106 (PRE), *U* 59 (NH)

##### Trichoneura

*grandiglumis* (Nees) Ekman, *S* 2136 (PRE), *U* 67 (NH)

\*\**schlechteri* Ekman, *S* 2170 (PRE), *U* 86 (NH)

##### Triraphis

*andropogonoides* (Steud.) E.Phillips, *Z* 4

*schinzii* Hack., *S* 2154 (PRE), *U* 57 (NH)

### CYNODONTEAE

#### Chloris

*gayana* Kunth, *S* 2196 (PRE), *U* 115 (NH)

*virgata* Sw., *S* 2187 (PRE)

*Cynodon dactylon* (L.) Pers., *S* 2149 (PRE), *U* 29 (NH)

*Eustachys paspaloides* (Vahl) Lanza & Mattei, *S* 2133 (PRE), *U* 42 (NH)

*Perotis patens* Gand., *S* 2169 (PRE), *U* 32 (NH)

### PANICOIDEAE

#### PANICEAE

*Acroceras macrum* Stapf, *B* 1708

\*\*\**Alloteropsis papillosa* Clayton, *S* 2166 (PRE), *U* 109 (NH)

##### Brachiaria

*chusqueoides* (Hack.) Clayton, *S* 2147 (PRE), *U* 55 (NH)

*deflexa* (Schumach.) C.E.Hubb. ex Robyns, *Ma* 102 (LUA), *H* 3047

*humidicola* (Rendle) Schweick., *S* 2157 (PRE)

*nigropedata* (Ficalho & Hiern) Stapf, *S* 2182 (PRE), *U* 95 (NH)



## Cenchrus

- \*brownii *Roem. & Schult.*, S 2129 (PRE)  
 ciliaris *L.*, S 2199 (PRE), U 111 (NH)

## Digitaria

- argyrothricha (*Andersson*) *Chiov.*, S 2163 (PRE), U 50 (NH)  
 ciliaris (*Retz.*) *Koeler*, MB 541  
 debilis (*Desf.*) *Willd.*, Ma 103 (LUAI), My 1088  
 \*didactyla *Willd.*, Z 11  
 eriantha *Steud.*, S 2126 (PRE), U 107 (NH)  
 gymnostachys *Pilg.*, U 112 (NH)  
 longiflora (*Retz.*) *Pers.*, S 2181 (PRE)  
 natalensis *Stent*, U 21 (NH)

## Echinochloa

- colona (*L.*) *Link*, S 2195 (PRE), U 118 (NH)  
 holubii (*Stapf*) *Stapf*, Z 12  
 pyramidalis (*Lam.*) *Hitchc. & Chase*, H 3057  
*Eriochloa meyeriana* (*Nees*) *Pilg.* subsp. *meyeriana*, N 382 (UZL), U 116 (NH)

Melinis repens (*Willd.*) *Zizka*

- subsp. *grandiflora* (*Hochst.*) *Zizka*, U 90 (NH)  
 subsp. *repens*, S 2198 (PRE), U 52 (NH)

Oplismenus hirtellus (*L.*) *P.Beauv.*, Z 5

## Panicum

- coloratum *L.* var. *coloratum*, N 385 (UZL)  
 deustum *Thunb.*, S 2139 (PRE), U 108 (NH)  
 genuflexum *Stapf*, Z 15  
 glandulopaniculatum *Renvoize*, B 1196  
 heterostachyum *Hack.*, Z 6  
 infestum *Peters*, Z 9  
 kalaharensis *Mez*, S 2184 (PRE)  
 laticomum *Nees*, Z 8  
 maximum *Jacq.*, S 2179 (PRE), U 92 (NH)  
 \*\*\* pleianthum *Peters*, S 2143 (PRE), U 49 (NH)

Paspalum scrobiculatum *L.*, V 38Sacciolepis curvata (*L.*) *Chase*, S 2150 (PRE), U 64 (NH)

## Setaria

- incrassata (*Hochst.*) *Hack.*, S 2194 (PRE), U 114 (NH)  
 megaphylla (*Steud.*) *T.Durand & Schinz*, S 2160 (PRE)  
 sphaecelata (*Schumach.*) *Moss* var. *sericea* (*Stapf*) *Clayton*, S 2132

(PRE), U 73 (NH)

*Stenotaphrum dimidiatum* (*L.*) *Brongn.*, S 2108 (PRE)*Tricholaena monachne* (*Trin.*) *Stapf & C.E.Hubb.*, Z 10*Urochloa mosambicensis* (*Hack.*) *Dandy*, S 2138 (PRE), U 96 (NH)

## ARUNDINELLEAE

*Tristachya nodiglumis* *K.Schum.*, S 2193 (PRE), U 105 (NH)

## ANDROPOGONEAE

## Andropogon

*eucomus* *A.Rich.*, MC 1138*gayanus* *Kunth* var. *polycladus* (*Hack.*) *Clayton*, S 2168 (PRE), U 84 (NH)*huillensis* *Rendle*, Ma 104 (LUAI), G 1*schirensis* *A.Rich.*, MC 1138*Bothriochloa insculpta* (*A.Rich.*) *A.Camus.*, Z 7\**Coix lacryma-jobi* *L.*, My 1235

## Cymbopogon

*excavatus* (*Hochst*) *Stapf ex Burtt Davy*, S 2138 (PRE), U 62 (NH)*nardus* (*L.*) *Rendle*, S 2197 (PRE), U 117 (NH)*pospischilii* (*K.Schum.*) *C.E. Hubb.*, PP 1068*Diheteropogon amplexens* (*Nees*) *Clayton*, MD 3942*Elionurus muticus* (*Spreng.*) *Kuntze*, S 2191 (PRE), U 102 (NH)*Hemarthria altissima* (*Poir.*) *Stapf & C.E.Hubb.*, MC 1163*Heteropogon contortus* (*L.*) *Roem. & Schult.*, MB 348

## Hyparrhenia

*dichroa* (*Steud.*) *Stapf*, MB 632*filipendula* (*Hochst.*) *Stapf* var. *filipendula*, S 2134 (PRE), U 43 (NH)*Hyperthelia dissoluta* (*Nees ex Steud.*) *Clayton*, S 2118 (PRE), U 41 (NH)*Imperata cylindrica* (*L.*) *Raeusch.*, S 2117 (PRE), U 16 (NH)*Ischaemum fasciculatum* *Brongn.*, S 2121 (PRE), U 78 (NH)*Monocymbium ceresiiforme* (*Nees*) *Stapf*, MC 1161*Sorghastrum stipoides* (*Kunth*) *Nash*, B 1579*Sorghum bicolor* (*L.*) *Moench* subsp. *arundinaceum* (*Desv.*) *De Wet & Harlan*, S 2198 (PRE), U 113 (NH)*Themeda triandra* *Forssk.*, S 2135 (PRE), U 39 (NH)*Trachypogon spicatus* (*L.f.*) *Kuntze*, S 2165 (PRE), U 44 (NH)*Urelytrum agropyroides* (*Hack.*) *Hack.*, S 2167 (PRE), U 37 (NH)



## OBITUARY

JOHANNES JACOBUS ADRIAAN VAN DER WALT (1938–2003)

Johannes Jacobus Adriaan (Adri) van der Walt (Figure 1), renowned for his research and books on *Pelargonium*, died on 28 November 2003 in Kleinmond, Western Cape.

He was born on 16 October 1938 in Krugersdorp, where he grew up and attended school. Though he never spoke of those days, I presume that his parental home was not too distant from open veld and that the young Adri roamed the fields and ridges in his free time, acquiring his love for plants which served him so well in later years. In 1956 he enrolled at the University of Pretoria, attaining a B.Sc. with Botany and Zoology in 1958. Having a didactic leaning, he enrolled for a Higher Education Diploma which he attained in 1961 and a B.Ed. attained in 1966, and from 1961 to 1967 taught biology for the Transvaal Education Department. Meanwhile he enrolled for a M.Sc. at the University of Pretoria, studying the secondary growth of certain lianes under the tutelage of Professors H.G. Schweickerdt (Van der Schijff 1977) and H.P. van der Schijff (Theron 1998), and graduating in 1963. In 1968 he was appointed lecturer of Botany at the University of Zululand near Empangeni. In 1969 he joined

the Botany Department of the University of Stellenbosch as lecturer and succeeded P.G. Jordaan as Professor in 1979 (Van der Walt 1987).

He also enrolled at Pretoria University for further studies on his research project, the taxonomy of *Commiphora* (Burseraceae) in South Africa and Namibia, for which he was awarded a doctorate in 1971.

At Stellenbosch University he consolidated his position and soon became known for his emphasis on teaching and research, aspects dear to the University. He started looking for a good long-term research project, and the catalyst was the meeting with botanical artist Ellaphie Ward-Hilhorst who had the ambition of making a water-colour painting of every *Pelargonium* species [see dedication to Ellaphie Ward-Hilhorst in *Flowering Plants of Africa* 54 (1995), and Rourke 1994]. This resulted in the first volume of *Pelargoniums of southern Africa* (Van der Walt 1977), the second and third volumes following after I had joined the team (Van der Walt & Vorster 1981, 1988). This work on *Pelargonium* became his main focus for the rest of his life. He was a great organizer, with a knack for persuading people to work for his goals, and at one time a considerable proportion of the department's staff was working for him. He recruited a number of local and international collaborators including Dr Mary Gibby at the Natural History Museum in London, Prof. Focke Albers of the University of Münster (both cytologists), and Dr Frédéric Demarne of CIRAD-IRAT Réunion (essential oils). His interest encompassed the whole of the Geraniaceae as having a bearing on *Pelargonium*, and his encouragement led to monographs of *Sarcocaulon* (Moffett 1979), *Monsonia* (Venter 1979), as well as an account of the South African *Erodium* species (Venter & Verhoeven 1990). In 1990 he organized an International Geraniaceae Symposium in Stellenbosch to which came the world's experts in this field (Vorster 1990).

Adri took research seriously. During the late 1970s and 1980s he travelled extensively throughout South Africa, collecting *Pelargonium* both as herbarium specimens and as living plants which were grown in his department's botanic garden. This living collection proved to be of great value, enabling several new species to be recognized, chromosome numbers to be determined, essential oil compositions to be established, anatomical studies to be executed, and illustrations to be prepared. Molecular research currently undertaken overseas is largely based on cuttings originating from this material. He preferred to refer to his chosen field as biosystematics rather than taxonomy, defining it as taxonomy beyond the alpha level.

He was a popular teacher on all levels. He had a way of attracting students and I well remember his engrossing lectures and happy field excursions when I first came to Stellenbosch. He had no difficulty in recruiting post-



FIGURE 1.—J.J.A. van der Walt (1938–2003).





FIGURE 2.—J.J.A. van der Walt admiring a *Commiphora* in Namibia, early 1980s.

graduate students. Many of his students eventually made headway in botany, including Jo Beyers, Matt Buys, Leanne Dreyer, Loretta Hugo, Gillian Maggs, Bettie Marais, Mike Müller, Koos Roux, Marianna Schonken, Mary Thompson, Ben-Erik van Wyk, and Alvaro Viljoen. He also had endless patience with amateur growers and interested members of the public, and this attribute, no less than his books and other publications, fostered a world-wide interest in the collection and cultivation of *Pelargonium* species as opposed to cultivars.

Honours and awards followed, including the Compton Prize for the best article in the *Journal of South African Botany* in 1988 and 1993, honorary membership of the International Geranium Society based in the USA in 1994, and the Havenga Prize for Biological Sciences awarded by the South African Academy for Science and the Arts in 2000. He served on the Board of the National Botanical Gardens from 1989 to 1992, and coined the name 'National Botanical Institute'.

Besides *Pelargonium*, his main interest lay in almost any team sport, as observer rather than participant, and invariably his day was started by reading the sport pages

of *Die Burger*. In his younger days he was fond of freshwater angling, sometimes with his pupils. He was also very fond of the veld and always hugely enjoyed the field trips and hunting down elusive species. He often spoke of his wonderful field trips with W. Giess (Kolberg 2001) in Namibia (Figure 2). He enjoyed telling about the outrageous escapades of his fellow students while at university, but it appears as if he himself never took part in these exercises. He was a devoted member of his church, the *Gereformeerde Kerk*, as well as a member of the *Broederbond*.

Prior to the commencement of his work on *Pelargonium*, he collected at least 306 numbers of herbarium specimens which are housed in PRE and PRU, and some in WIND. No collecting register of this period seems to be in existence. Subsequently his numbering system became somewhat confusing in that the material which he and his collaborators collected were assigned STEU numbers which were also applied to plants in the living collections, and starting at 400. Some of these specimens bear a Van der Walt collection number as well as an identical STEU number, whereas others have different Van der Walt and STEU numbers. It is recommended that these specimens be referred to as, for example, *Van der Walt 538 sub STEU483* or *Van der Walt s.n. sub STEU2786*. Again, no collecting register exists: the data were entered in little 164 × 87 mm landscape format pocketbooks, one accession to a page. There are 30 of these books containing 4 371 accessions collected by Van der Walt as well as his collaborators. At the time of writing, these books are still in the Botany Department, University of Stellenbosch. The main set of the *Pelargonium* herbarium collection is in PRE, with at least some duplicates in NBG, STEU, K, MO, and BM in order of abundance.

Surprisingly, he took early retirement in 1996 at the age of 58 and made what he called a clean break with botany. He settled at Kleinmond where he lived out his days. He also acquired a small farm in the Caledon District where he potted about, keeping bees, experimenting with growing indigenous plants, and battling with alien invaders, while delighting in the re-appearance of indigenous species after clearing the land.

Shortly before his retirement he was diagnosed with cancer. The treatment appeared to be successful, but after a few years the cancer flared up again and turned out to be terminal, mercifully rapidly so.

He is survived by his wife Isabel, and three of their four children. All three of these scions are involved with plants: Dawid as nurseryman, Riaan as conservation officer, and Gerda as farmer.

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